CHAPTER 3.2
Geomorphology, Hydrology, and Water Quality

This Chapter discusses the existing environment of the Shasta River watershed (Program Area); identifies potential impacts on geomorphology, hydrology, and water quality in the Shasta Valley related to the Shasta River Watershed-wide Permitting Program (Program); and proposes mitigation measures for those impacts determined to be significant. Information on the environmental setting in this Chapter was compiled from field reconnaissance of the Program Area, review of various reports and studies provided by the California Department of Fish and Game (CDFG) and the Shasta Valley Resource Conservation District (SVRCD), peer-reviewed scientific literature, and federal and state resource agency websites, databases, and reports.

3.2.1 Environmental Setting

Regional Setting – The Klamath River Basin

The Shasta River is one of the major tributaries to the Klamath River. The Klamath River originates in south-central Oregon, east of the Cascade Mountain Range. The 263-mile river flows in a general southwesterly direction through Oregon into California. In California, the Klamath River continues flowing southwesterly before turning northwesterly near its confluence with the Trinity River and continuing to the Pacific Ocean. The Klamath River drains about 15,600 square miles (of which 3,600 square miles are considered non-contributing) in California and Oregon, and is California's second largest river system (Ayres and Associates, 1999; CDFG 2002a in CDFG, 2004).

Much of the natural flow in the Klamath River basin is regulated. Four hydroelectric facilities and two other diversion and regulation dams on the mainstem system, as well as numerous public and private water diversion projects, regulate and alter the flow of the river. In the upper Klamath River basin (upstream of Keno Reservoir), a large volume of water is stored and then diverted for agricultural purposes during the spring-summer growing season by private diverters and the U.S. Bureau of Reclamation's (USBR) Klamath Project (CDFG, 2004). The Klamath Project impounds water at Upper Klamath Lake. Substantial water diversion and water use also occur in other areas of the Klamath River basin, including the Program Area. The Department of Water Resources (DWR) estimated that current annual agricultural water use in the Program Area totals 110,000 acre-feet (DWR, 1997 in CDFG, 2004). In comparison, average annual irrigation and urban water use above Keno Dam in Oregon totals 503,700 acre-feet (DWR, 1997 in CDFG, 2004).

Shasta River Watershed

The Program Area comprises the entire Shasta River watershed, which is located in Siskiyou County in central-northern California. The Program Area is approximately 795 square miles in extent; it is bounded to the north by the Siskiyou Range, to the west by the Klamath Mountains, to the east by the Cascade Range, and to the south by Mount Shasta and Mount Eddy (North Coast Regional Water Quality Control Board (NCRWQCB), 2006a). Mount Shasta (a Cascade volcano), standing at an elevation of 14,162 feet above mean sea level (amsl), is the dominant topographic feature in the watershed and contributes significantly to the hydrology of the basin.

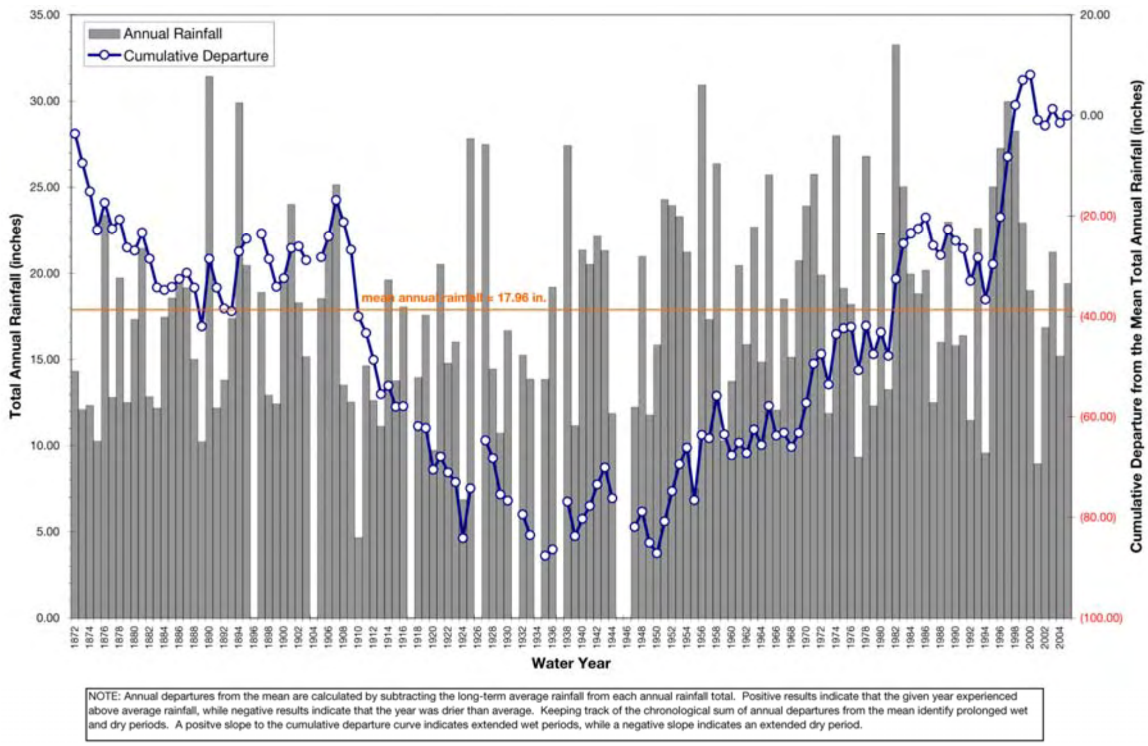
The Shasta River originates on the north slope of Mount Eddy. Flow in the Shasta River is derived from both rainfall and snowmelt. The watershed drains a portion of the Cascade Province to the east and a portion of the Klamath Province to the west. Snowmelt from Mount Shasta contributes significantly to the surface water and groundwater hydrology of the basin. Mount Shasta has permanent glaciers and a snow pack that usually persists, to varying degrees, on a year-round basis. Water from melted snow percolates down through porous volcanic rocks, follows the gradient and flows subsurface toward the Shasta River Valley (Shasta Valley), and eventually manifests as springs and seeps somewhere on the valley margin or floor. As such, Mount Shasta is a constant source of surface and spring flow to the Shasta River and its eastern tributaries.

The Shasta River is one of four major tributaries of the Klamath River within California, entering the Klamath near River Mile (RM) 177 at an elevation of approximately 2,020 feet amsl. Over a total river length of about 50 miles, the Shasta River flows in a general south-to-north direction from its origin on Mount Eddy to its mouth at the Klamath River confluence. The principal tributaries to the Shasta River include: Eddy Creek, Beaughton Creek, Carrick Creek, Julian Creek, Jackson Creek, Parks Creek, Big Springs Creek, Willow Creek, Yreka Creek, Guys Gulch, Oregon Slough, and the Little Shasta River (NCRWQCB, 2006a).

Climate and Precipitation

The Program Area has a Mediterranean climate characterized by warm, dry summers and cold, wet winters. In general, the Shasta Valley's climate is relatively dry and average precipitation on the valley floor is much less than the surrounding mountain areas. Annual precipitation ranges from less than 15 inches in parts of the Valley to over 45 inches in the Eddy and Klamath Mountains, while precipitation on Mount Shasta ranges from 85 to 125 inches (WRCC, 2007; NCRWQCB, 2006a). Moisture laden air masses moving eastward from the Pacific Ocean lose water as they rise over the Klamath Mountains, thus creating a rain shadow effect on the Shasta Valley (Klamath Resource Information System (KRIS), 2007). The wet season generally lasts from October to April and much of the winter precipitation falls as snow. In general, the amount of precipitation at any place and the proportion of precipitation that falls as snow are related directly to elevation. The annual rainfall trend recorded at Yreka from water year[1] (WY) 1872 to 2005 is shown in **Figure 3.2-1**.

[1] A water year (WY) begins on October 1 of the previous year and ends on September 30 of the designated WY. For example, WY 2004 comprises the period of October 1, 2003 through September 30, 2004.



SOURCE: Vose et al. (1992); CDEC (2007); WRCC (2007)

Shasta River Watershed-Wide Permitting Program . 206063

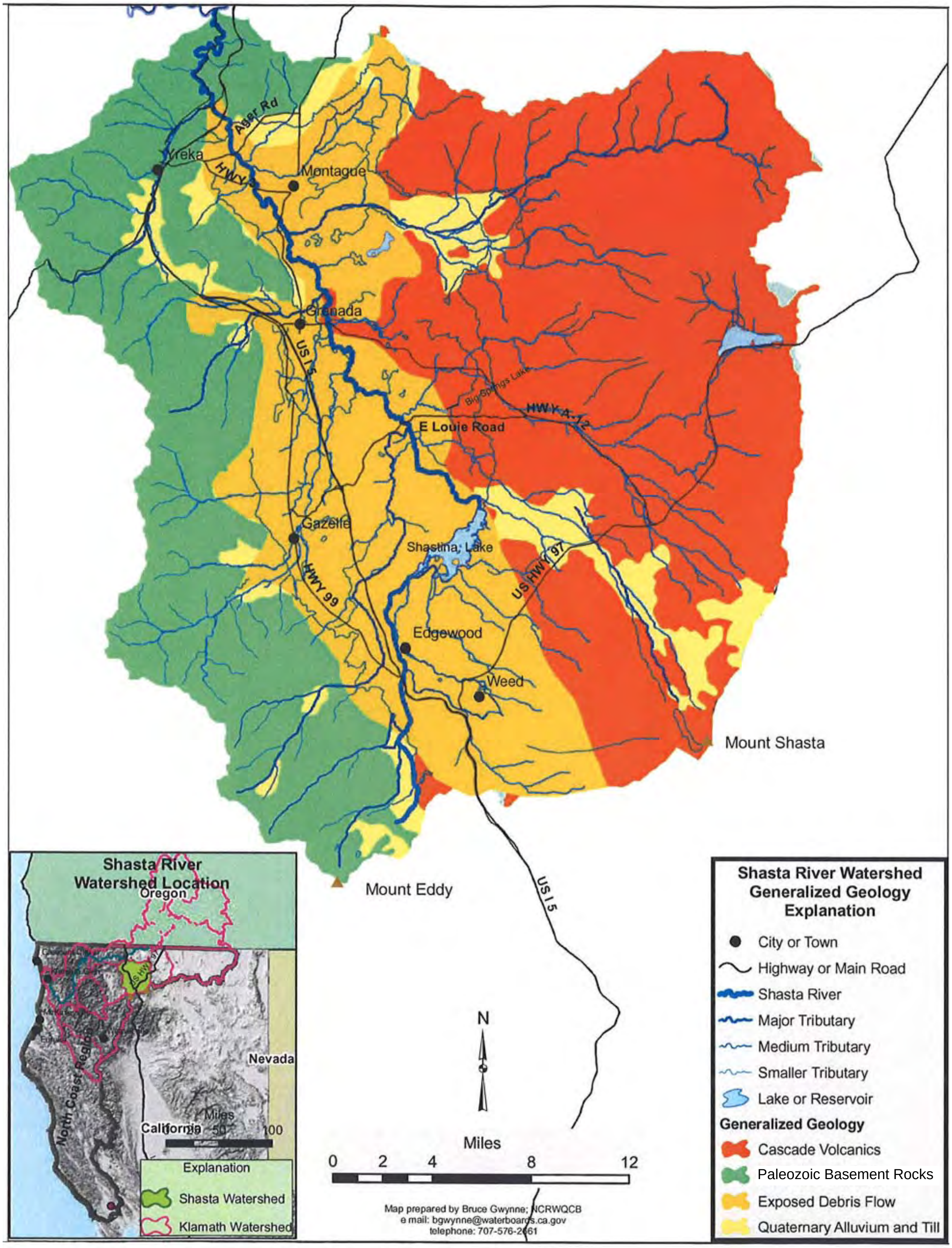
Figure 3.2-1
Annual Precipitation at Yreka, CA
(Water Years 1872-2005)

Geology

The Program Area spans the juncture of two major geomorphic provinces:[2] the Klamath Mountains province (relatively old metamorphic and sedimentary rocks on the west) and the Cascade Range province (relatively young volcanic rocks on the east). The contact between these two provinces is overlain by a low-gradient valley floor (Shasta Valley), which is built-up primarily from an ancient debris avalanche deposit and Quaternary alluvium (**Figure 3.2-2**).

On the east side of the watershed, the mountains of the Cascade Range province are primarily extrusive igneous rocks and some intrusive rocks that have been exposed by erosion. The Cascade Range province is divided into the older (Eocene-Miocene) Western Cascade Range volcanics and the younger (Pliocene-Pleistocene) High Cascade Range volcanics (Ayres Associates, 1999). The younger rocks have undergone some uplift, but the rocks are not strongly deformed. The older rocks consist of andesite, olivine basalt, and basaltic andesite (Wagner and Saucedo, 1987); these rocks are exposed along a wide swath on the east side of the Western Cascades volcanic deposits and also extend due north from the north side of Mount Shasta into Oregon. Younger High Cascades volcanic formations comprise the surface deposits on and immediately adjacent to Mount Shasta.

[2] Geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform; eleven provinces are distinguished in California (CGS, 2002) with each region displaying unique, defining features based on geology, faults, topographic relief and climate.



SOURCE: modified from NCRWQCB (2006a)

Figure 3.2-2
Shasta River Watershed Geology

The mountains along the west side of the Program Area, the Klamath Range province, are underlain by older rocks that include a variety of metamorphic rocks, slightly metamorphosed sedimentary rocks and volcanics, granite and diorite, mafic and ultramafic rocks that are largely altered to serpentine, and by eastward-dipping marine sandstone and conglomerate of the Upper Cretaceous Hornbrook Formation (NCRWQCB, 2006a; Crandell, 1989). This complex has been deformed by folding, intense shearing, and thrust faulting. Deformation in the last 1 to 2 million years has resulted in uplift of the mountains along the west flank of the Shasta Valley.

The floor of the Shasta Valley consists primarily of Quaternary alluvium and the deposit of an ancient debris avalanche from the ancestral Mount Shasta. The alluvial portions of the Shasta Valley can be divided into two areas: the gently eastward sloping alluvial plain along the western margin of the valley, and the older, dissected and rounded, coalescing fans covering the north end of the valley. The remainder of the valley floor is dominated by the debris avalanche deposit.

Valley Morphology and the Pleistocene Debris Avalanche

It is generally accepted that the present morphology of the Shasta Valley floor was largely shaped by a gigantic debris avalanche (described by Crandell (1989)) that occurred 300,000 to 380,000 years ago. The theory maintains that a massive amount of material was entrained in a huge landslide from the ancestral Mount Shasta. Large andesite blocks were scattered down the valley and a finer, more liquid matrix (similar to a lahar, or mudflow) flowed around them and filled in the Valley. The avalanche deposit covers an area of approximately 675 square kilometers and is overlain on the east by more recent basaltic lava flows and on the south by andesitic lava flows, lahars, and alluvium from Mount Shasta. Two texturally distinct parts characterize the avalanche deposit: the block facies and the matrix facies. The matrix facies consist of an unsorted and unstratified mixture of pebbles, cobbles, and boulders in compact silty sand; texturally it resembles the deposit of a mudflow (Crandell, 1989). The block facies are responsible for the many small hillocks throughout the Shasta Valley and include individual andesite blocks (many of which are pervasively shattered) ranging in size from tens to hundreds of meters in maximum dimension.

The valley morphology, in turn, controls the development and evolution of drainage networks and stream channels. The morphology of the deposit has changed little since its emplacement. The lack of a well-integrated drainage system, as well as the absence of deep and widespread dissection of the deposit, is due to its gently sloping surface and to the presence of resistant rock at the head of the lower Shasta River canyon northwest of Montague. This bedrock threshold serves as a base-level control for the Shasta River and the Shasta Valley. Consequently, the Shasta River within the Shasta Valley has since persisted as a low gradient, low energy system; this is particularly evident in the highly sinuous, meandering portion of the river between Big Springs and the Little Shasta River.

Flooding

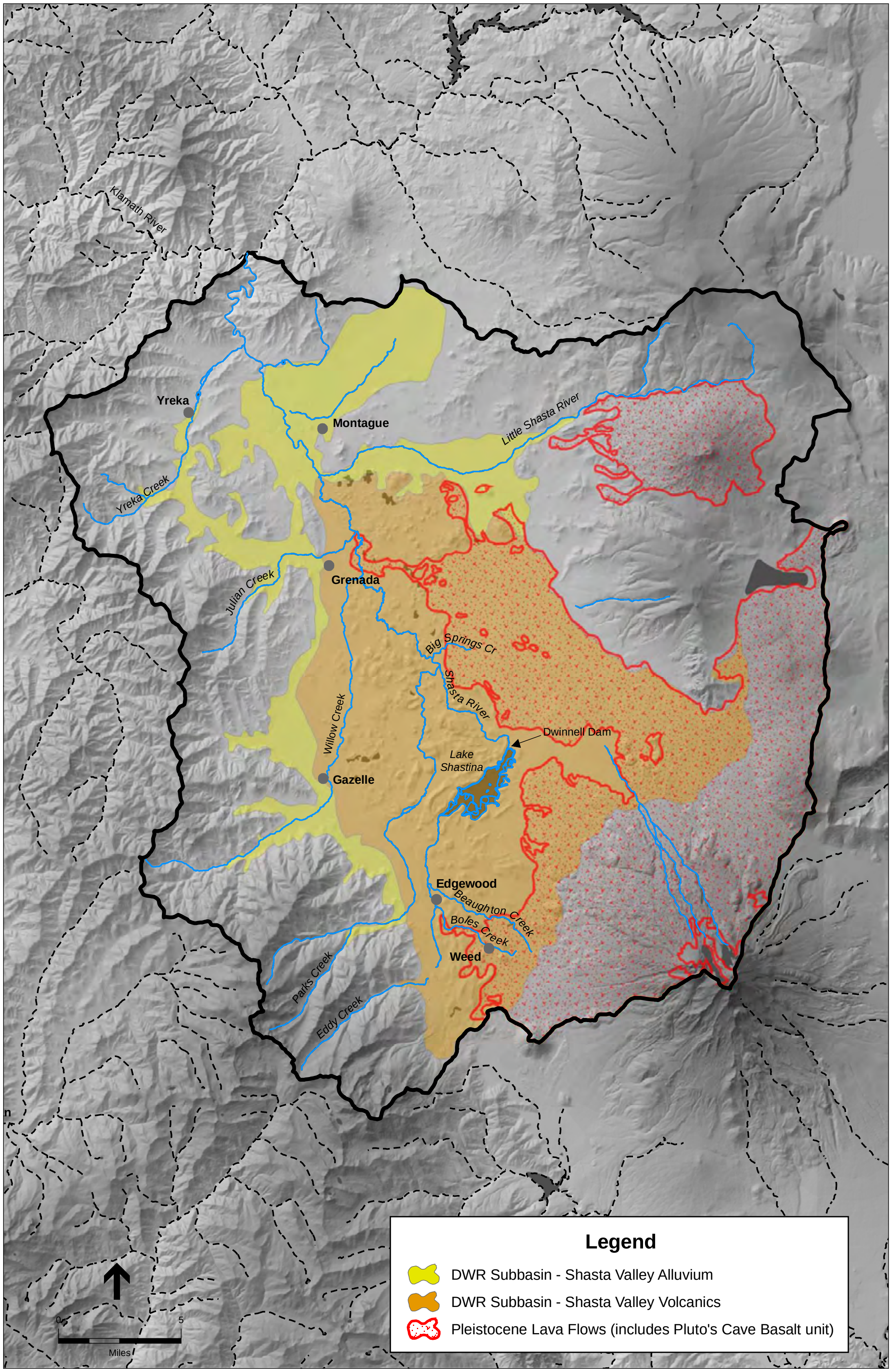
The construction of Dwinnell Dam (forming Lake Shastina, otherwise known as Dwinnell Reservoir) on the Shasta River in 1928 reduced flooding within the Shasta Valley.[3] Annual peak flows of 21,500 cubic feet per second (cfs) and 10,900 cfs were recorded at the U.S. Geological Survey (USGS) gaging station (no. 11517500, Shasta River near Yreka) on December 22, 1964 and on January 1, 1997, respectively (USGS, 2007). Otherwise, annual flood peaks have rarely exceeded 4,000 cfs since this gage began operating in 1934.

The Federal Emergency Management Agency (FEMA) is responsible for mapping areas subject to flooding during a 100-year flood event (i.e., one percent chance of occurring in a given year). FEMA (2004) has delineated the 100-year floodplain for the Program Area. Principally as a result of Dwinnell Dam, the 100-year floodplain for the Shasta River is very narrow, ranging from 200 feet to less than 2,000 wide for the most part. Wider, more notable (yet still relatively small in surface extent) 100-year floodplains are found at the confluence of Willow Creek and Julian Creek and at the mouth of Parks Creek.

Groundwater Hydrology

Owing to the unique geology of the Program Area, groundwater movement and storage is complex and does not easily lend itself to simplification into a single, homogeneous groundwater basin. The important water-bearing formations within the Shasta Valley are Quaternary alluvium (along the extreme western margin of the valley and in the area north of Montague), Pleistocene basalt formations (southeastern part of the valley), and the Pleistocene debris avalanche deposit (throughout the middle of the valley). DWR (2004) depicts two general groundwater subbasins within the valley: the Shasta Valley Alluvium and the Shasta Valley Volcanics (**Figure 3.2-3**). However, only a portion of the volcanic subbasin is actually comprised of lava flow formations (mostly basalt flows) (Figure 3.2-3), much of which are collectively referred to as the Pluto's Cave basalt. The remainder of the volcanic subbasin (i.e., that portion within the central part of the valley) is primarily comprised of the Pleistocene debris avalanche deposit. Though the degree to which these geologic units are hydraulically connected remains uncertain, all of these units serve as significant groundwater storage and recharge areas within the Shasta Valley. However, the Pluto's Cave basalt constitutes the principal water-bearing unit in the Shasta Valley and is particularly important with respect to the surface water characteristics of the Shasta River. The Pluto's Cave basalt directly supports many of the springs in the valley and groundwater discharge from this unit appears to be the primary source of cold water inflow to the Shasta River below Dwinnell Dam during the summer and fall months (DWR, 2007). Further, the Pluto's Cave basalt typically yields abundant water for irrigation, stock, and domestic wells and feeds the springs that support surface flow in the mainstem Shasta River downstream of Dwinnell Dam. Due to the complexity of the region with respect to the extensive network of volcanic recharge and storage areas, the amount of groundwater in storage has not been estimated (DWR, 2004).

[3] With respect to the overall flow regime, it should be noted that the flow from springs and seeps exerts a strong influence upon the Shasta River's flow regime, and in some ways these discharges are just as important (if not more so) as direct surface runoff.



SOURCE: ESA (2007); DWR (2004); Wagner and Saucedo (1987), as depicted by DWR (2007)

Figure 3.2-3
Shasta River Watershed Groundwater Basins and Selected Geology Features

Groundwater dynamics exert a strong influence on the volume and quality of surface flow in the Shasta River and its tributaries. Throughout Shasta Valley the depth to the water table varies greatly, though depths tend to be greatest at the south end of the valley along the eastern and western margins. Recharge to groundwater is affected by deep infiltration of precipitation that falls on the tributary drainage area, principally the western slopes of Mount Shasta, and by seepage from streams (Mack, 1960). Further, the application of surface water through irrigation, as well as surface water conveyance losses, may be an important source of groundwater recharge in parts of the valley (DWR, 2007). Precipitation on the valley floor is generally not sufficient to contribute much to recharge of the groundwater. Groundwater discharge in Shasta Valley occurs principally by seepage into streams (Mack, 1960). Springs and seeps occur in some exposures of all the geologic formations in the Shasta Valley (particularly near the borders of the valley and along the courses of major streams). However, the young basalt formations on the eastern side are the most prolific in terms of spring and seep development and production. For example, historic flows at the mouth of Big Springs Creek were apparently on the order of 100 to 120 cfs and were largely unaffected by climatic variability (SVRCD, 2005). Percolation of surface water applied for irrigation may also be contributing to Shasta River base flow by increasing groundwater discharge to the river (DWR, 2007).

Human Influence on Hydrologic and Geomorphic Processes

Human settlement and land management activities have had a measurable and lasting effect on the natural hydrologic and geomorphic processes within the Program Area. Hence, what is seen today in the Program Area is quite different from 150 years ago. In terms of their effect on watershed processes, these activities can be divided into upland management activities that produce downslope and downstream impacts, and valley bottom/stream channel management activities that more directly affect the geomorphology of the main river system. The most important changes and land management actions include: timber harvesting and road construction, fire suppression, beaver removal, mining and dredging operations, and agricultural practices.

Upland Management

The Shasta River and the Shasta Valley have been subject to extensive human alteration since the mid-1800s. Hillslope processes have been altered over the past century by the effects of hydraulic mining, road and skid trail construction, and vegetation removal by fires, fire suppression, grazing, and timber harvest (LaPlante, 2001; National Research Council (NRC), 2004; NCRWQCB, 2006a). In the upland areas, the steep mountainous terrain is naturally susceptible to erosion, but the extent and severity of erosion varies in response to land use activities such as timber harvest and road construction, as well as to regional flood events (LaPlante, 2001). Roads were first constructed, and timber harvesting was initiated, on private lands to supply early mining, railroad and housing needs in the 1800s and early 1900s. Beginning in the 1950s, National Forest lands were intensively managed for timber harvest (Webb, 2007). The bulk of the National Forest lands in the Program Area are within the Shasta-Trinity National Forest, in the southwest (e.g., Parks Creek headwaters) and southeast (e.g., northern flank of Mount Shasta) portions of the watershed. Upslope forest management has had an effect on downstream channel systems largely through altered infiltration rates, altered peak runoff timing, increased bank erosion, and deposition of fine sediments in low gradient sections of the mainstem Shasta River.

Timber Harvesting and Road Construction

Timber was originally needed for settlement and early mining operations in the Shasta Valley near Yreka beginning in the 1850s (gold was discovered in Yreka in 1851). Commercial logging began in earnest after World War II and was accompanied by the widespread construction of logging roads and skid trails on public lands. Today, mixed conifer-hardwood forested lands exist primarily in the upper watersheds of Dale Creek, Eddy Creek, Yreka Creek, Parks Creek, the Little Shasta River, and the upper Shasta River (Webb, 2007). These forested lands are primarily owned and managed by either the U.S. Forest Service or large private timber companies.

Erosion and sedimentation are natural processes, but both have been heightened by human activities in the upland watershed areas. Construction of roads constitutes one major category of soil disturbance and sediment transport into streams. Regional and local studies have identified road and skid trail construction, including legacy features from previous forest operations, as one of the largest single sources of accelerated erosion in managed watershed areas (LaPlante, 2001; NRC, 2004). For example, Parks Creek contributes excessive fine sediments to the mainstem Shasta River (LaPlante, 2001). The channel of Parks Creek has been altered as a result of management activities within the watershed over the last 40 years (LaPlante, 2001). Road building and harvesting activities beginning in the 1960s were extensive, resulting in increases in surface runoff from skid trails, roads, and harvested areas, and subsequent increases in peak flows within the channel, bank erosion rates, and bedload transport rates. Medium- and fine-grained sediment derived from logging roads and skid trails in the watershed continues to accumulate in the Parks Creek channel and further downstream in the mainstem Shasta River (LaPlante, 2001).

Upland Fire Suppression

Wildfire is one of the triggers for generating high rates of surface erosion in areas with erodible soils, especially in a climatic regime where low precipitation contributes to excessively long recovery periods. Surface erosion from large exposures of bare soil following wild fires generates fine sediments that are easily transported to downstream areas. Dry upland forest sites may require decades for recovery due to slow tree regeneration, causing an extended window of cumulative watershed effects related to flow and fine sediment (Kier Associates, 2005). Throughout the west, decades of fire suppression has increased the susceptibility and potential magnitude of wildfire in forested landscapes. Fire suppression has been a long-standing management action on National Forest lands in the upper Shasta River watershed (Webb, 2007).

Valley Bottom and Stream Channel Management

Stream channels in the Program Area, especially in the low-gradient valley sections, have been modified almost since first European occupation of the watershed. Activities such as beaver trapping, localized alluvial gold mining (Yreka Creek and Shasta Canyon), bank protection, streamflow manipulations, dam building, and upland land management continue to dominate the geomorphic function of the Shasta River and its tributaries.

Beaver Removal

One of the earliest noted events related to impacts to the natural hydrology of the Program Area was the trapping and removal of beaver, which began in the 1820s with a group from the Hudson's Bay Company (Webb, 2007). Beaver dams add complexity to stream habitat. The stepped profiles of beaver-influenced rivers, with narrow, deep, sinuous reaches above the ponds and shallower reaches of swifter flow below the ponds, maximize the diversity of riparian and aquatic habitats (Wohl, 2005). Beaver dams reduce flow velocities, increase surface water storage, provide slack water habitat, maintain shallow groundwater levels and base streamflow throughout the summer months, increase flooding and floodplain deposition, and increase the interconnectedness of the floodplain with the adjacent stream channel system. Beaver ponds are also known to provide excellent habitat for juvenile coho salmon (*Oncorhynchus kisutch*) (Bergstrom, 1985, in Sommarstrom et al., 1990). With the removal of beavers, many beneficial attributes that their dams added to the stream system were lost.

Mining and Dredging Operations

About the time the beaver population was decimated, land use shifted to large scale mining, particularly gold mining. Gold was discovered in Yreka in the spring of 1851. The earliest phase of placer mining in the northern Shasta Valley was dominated by sluice mining. Most gold mining within the watershed took place on Yreka Flat and in the lower Shasta River canyon. The need for water in placer mining was paramount, and elaborate ditches were constructed to deliver diverted waters to mine sites (sometimes from miles away). Many of these early diversions are either still functioning as agricultural diversions or are clearly visible on the landscape. Mining activity was already beginning to diminish by the end of the 1850s, but it continued in the Program Area into the twentieth century (Webb, 2007).

Placer and dredge mining has three basic effects on river form and function (Wohl, 2005). First, the disruption of bed and bank sediment renders this material more susceptible to being moved by the river flow. This can cause down-cutting of the river at the location of the mining or change a meandering river to a braided river (Hilmes and Wohl, 1995). Smaller sediments are preferentially mobilized and winnowed from the disturbed area and accumulate downstream, which can reduce channel capacity and cause more flooding. The remaining coarse material is too large to be moved frequently or to provide spawning gravel for fish, whereas the finer sediment carried downstream preferentially fills pools and covers spawning gravel downstream. The river at the mining site remains less stable for decades after mining because the fine-grained bank sediment that once supported stabilizing riparian vegetation is gone (Hilmes and Wohl, 1995). The mining process disrupts the stratigraphy of the channel deposits and greatly increases permeability of the remaining coarse sediment. This can lead to river infiltration and increased subsurface flow and explains why surface flow dries up in summer. These persistent geomorphic and hydrologic impacts are not easily corrected or mitigated.

The second basic effect concerns the introduction of toxic heavy metals, including mercury, used during mining into the stream and retained in valley-bottom sediments. These can have an impact on the biological diversity and productivity of aquatic species in the river system (Wohl, 2005). Third, placer mining indirectly affects the channel by altering the amounts of water and sediment entering the rivers. These alterations may result from the extensive timber harvest that is required to support large scale mining operations and the settlement (such as Yreka) that accompanies mining. Mining and deforestation effects greatly exceeded the impacts associated with beaver removal, yet both actions likely had significant consequences and continue to impact the Program Area to this day.

Agricultural Practices and Water Management

Agricultural use of water in the Program Area began with the settlement of miners in the early 1850s. By the turn of the twentieth century, gold mining had diminished in the watershed and agricultural development became the economic focus, resulting in increased irrigation and water use. In the early 1900s, four water supply agencies were formed in the Program Area. The Shasta River Water Association (SRWA) is a corporation formed in 1912, and serves an area near the town of Montague along the west side of the Shasta Valley. The Grenada Irrigation District (GID) serving the area located west of Grenada, the Montague Water Conservation District (MWCD), serving the Little Shasta Valley and the northeast part of the Shasta Valley, and the Big Springs Irrigation District (BSID), serving the area north of Big Springs Lake formed under the California Irrigation District Act in 1921, 1925, and 1927, respectively (NCRWQCB, 2006a). Soon thereafter, the increasing demand for the water resources of the Shasta Valley prompted a formal adjudication of water rights within the watershed.

In 1932, the Siskiyou County Superior Court adjudicated the relative rights based upon prior appropriation of various claimants to surface water resources in the Shasta River and its tributaries, and thereafter issued the Shasta River Judgment and Decree (1932) (Shasta River Decree) (NCRWQCB, 2006a). DWR provides watermaster service that has been apportioning water within the watershed since 1934. In general, the watermaster is responsible for apportioning available water in order of priority of right as set forth in the Shasta River Decree. Riparian water rights in the Shasta River watershed are not adjudicated and are not regulated by the watermaster. Also, the court in its 1932 adjudication did not address groundwater, which as mentioned earlier is critical for support of baseflow (NRC, 2004). The Shasta River is fully appropriated from May 1 through October 31 (State Water Resources Control Board (SWRCB) 1998). A summary of the allotments in the Program Area from the 1932 adjudication is presented in **Table 3.2-1**.

The most notable water storage facility for irrigation and consumptive water use in the Program Area is Dwinnell Dam. Dwinnell Dam, which MWCD owns and operates, was completed in 1928. It captures runoff from approximately 117 square miles of the upper Shasta River watershed (about 15 percent of the entire Program Area), forming Lake Shastina (also known as Dwinnell Reservoir). MWCD has appropriative rights to store up to 49,000 acre-feet (35,000 acre-feet from the Shasta River and 14,000 acre-feet from Parks Creek) of water in Lake Shastina from October to July of each year. Although a relatively small reservoir, it only fills during above-normal runoff years due to the relatively modest yield from upstream watershed areas, seasonal water use, and appreciable seepage loss from the reservoir (Vignola and Deas, 2005). Lake Shastina inflow is primarily derived from the Shasta River. However, inflows from Carrick Creek, other smaller intermittent streams, other surface and subsurface inflow, as well as precipitation contribute to the reservoir. Additionally, up to 14,000 cfs of water from Parks Creek

TABLE 3.2-1
SUMMARY OF ALLOTMENTS FROM THE 1932 SHASTA RIVER ADJUDICATION

Location / Water Body	Total Allotment (cfs)
Irrigation Season	
Shasta River upstream of the confluence with Big Springs Creek	111.4
Boles Creek and Tributaries	17.6
Beaughton Creek and Tributaries	10.3
Jackson Creek and Tributaries	2.8
Carrick Creek and Tributaries	11.7
Parks Creek and Tributaries	56.3
Shasta River downstream of the confluence with Big Springs Creek, including Big Springs Creek and Tributaries	184.8
Little Shasta River and Tributaries	90.0
Willow Creek and Tributaries	55.7
Yreka Creek and Tributaries	36.0
Miscellaneous Springs, Gulches, and Sloughs	32.9
TOTAL	**609.5**
Non-Irrigation Season	
Shasta River and its Tributaries	327.4

SOURCE: 1932 Shasta River Adjudication and Decree, as summarized and presented in NCRWQCB (2006a)

is diverted from October 1 to June 15 into the Shasta River upstream of Dwinnell Dam for storage in Lake Shastina under an MWCD water right.

Agricultural activities have had effects (direct and indirect) on the geomorphology and water quality of the stream system and have contributed to the decrease in the productivity of the Shasta River's anadromous fisheries (as discussed in Chapter 3.3, Biological Resources: Fisheries and Aquatic Habitat). Water diversions, primarily for agricultural purposes, have led to decreased surface flows in the spring and summer months, thereby reducing the amount of instream habitat and locally increasing ambient surface water temperatures.

Grazing

In the Valley upstream of the lower Shasta River, grazing has been responsible for most of the loss of vegetation in the riparian corridor; where intense, unfenced grazing has occurred, trampling and removal of vegetation have commonly led to accelerated bank erosion, loss of shading, reduced accumulation of local woody debris, loss of pool habitat to sedimentation, loss of channel complexity and cover, and degradation of water quality (NRC, 2004). Some of the larger impoundments within the watershed, most of which are related to agricultural practices, bring about the most dramatic changes in channel morphology and function.

Livestock grazing is a Covered Activity under the Program and, similar to some other Covered Activities, it is not new; rather, it has been occurring in the Program Area for decades. Hence, authorizing livestock grazing as part of the Program will not cause the level of grazing to increase or result in any impacts in addition to those that are already part of baseline conditions in the Program Area. In fact, the Program will likely reduce the impacts of grazing by excluding livestock from some riparian areas by installing and maintaining fencing (see ITP and MLTC Covered Activity 5). Also, where riparian fencing is constructed as part of the Program, any grazing of livestock adjacent to the channel or within the bed, bank, or channel of the Shasta River or its tributaries may only occur in accordance with a grazing management plan that will result in improved riparian function and enhanced aquatic habitat.

Dams and Impoundments

Dwinnell Dam, Greenhorn Dam, and, to a lesser degree, a number of smaller impoundments, have altered the hydrologic and geomorphic properties of rivers and streams in the watershed. Dams disrupt the longitudinal continuity of the river system, and can have profound effects on downstream channel form through alteration of the flow regime and disruption of sediment transport processes. Dams and impoundments typically reduce flow velocity, increase flow depth, and increase sedimentation. With the exception of above-average water years, when Lake Shastina is full, no flow is released from Dwinnell Dam except for small amounts to specific water users downstream (NRC, 2004). Dwinnell Dam has also reduced the magnitude and frequency of floods on the Shasta River, and this has diminished the dynamic nature of the river downstream, as well as the frequency of large flows necessary to flush fine sediments from gravel deposits.

These dams have also exacerbated the lack of coarse sediments and gravel in the Shasta River and the lower reaches of some of its main tributaries. Dams trap coarse sediments that are essential in maintaining downstream channel form, and the dam-induced change in the natural sediment budget typically results in downstream erosion and channel incision for some years following construction. Dwinnell Dam traps all of the gravel and coarse sediment from the upper Shasta River watershed; Greenhorn Dam blocks the downstream input of gravel to Yreka Creek and the lower Shasta River (within the canyon). The smaller impoundments allow fine sediments to settle and bury river gravels (where the gravels still exist).

Stream Restoration Efforts

In many areas within the Program Area, the impacts of past and present activities have been acknowledged and documented, and measures to improve water quality and restore the geomorphic structure and ecological function of the riverine habitat have been implemented. A number of groups and concerned citizens, including the SVRCD and the Shasta River Coordinated Resources Management and Planning Committee (Shasta River CRMP), have been working to manage and protect the natural resources of the Shasta River and its watershed lands. SVRCD, like other Resource Conservation Districts, is a local unit of government established to carry out natural resource management programs. SVRCD works to benefit agriculture while also protecting fish, wildlife, plants, and water quality (NCRWQCB, 2006a). The Shasta River CRMP, a subcommittee of SVRCD, has also been making significant strides in the restoration and management of the Shasta River and its tributaries (NCRWQCB, 2006a).

Since 1986, with over $11 million in funding from local, state, and federal agencies, SVRCD and the Shasta River CRMP have been involved in developing and implementing many significant and beneficial water quality and habitat restoration projects. From 1986 to the present, over 160 projects have been implemented within the Program Area (NCRWQCB, 2006a) (see also the discussion of restoration projects in Chapter 4). For the most part, these projects can be described by the following general categories of project type: riparian fencing, riparian planting, bank stabilization, habitat restoration, agricultural tailwater management, water quality and flow monitoring, fish screening and fish passage, and education and outreach.

Existing Hydrologic and Geomorphic Conditions

Based on the objectives of the Program, review of SVRCD (2005), and consideration of the Program Area climate, topography, hydrology, and geology, the Program Area is delineated into eight sub-watersheds (or sub-reaches, in regard to the mainstem Shasta River) in order to describe existing conditions: Shasta Valley (Shasta River from Dwinnell Dam to the head of the canyon), lower Shasta River (the canyon), upper Shasta River (upstream of Dwinnell Dam, including Boles Creek, Beaughton Creek, and Carrick Creek), Parks Creek, other Westside tributaries (including Julian Creek and Willow Creek), Yreka Creek, Little Shasta River, and the Eastside (volcanic) tributaries (namely the area draining to Big Springs Creek). These basins, as well as the principal tributaries within the Program Area, are shown in **Figure 3.2-4**.

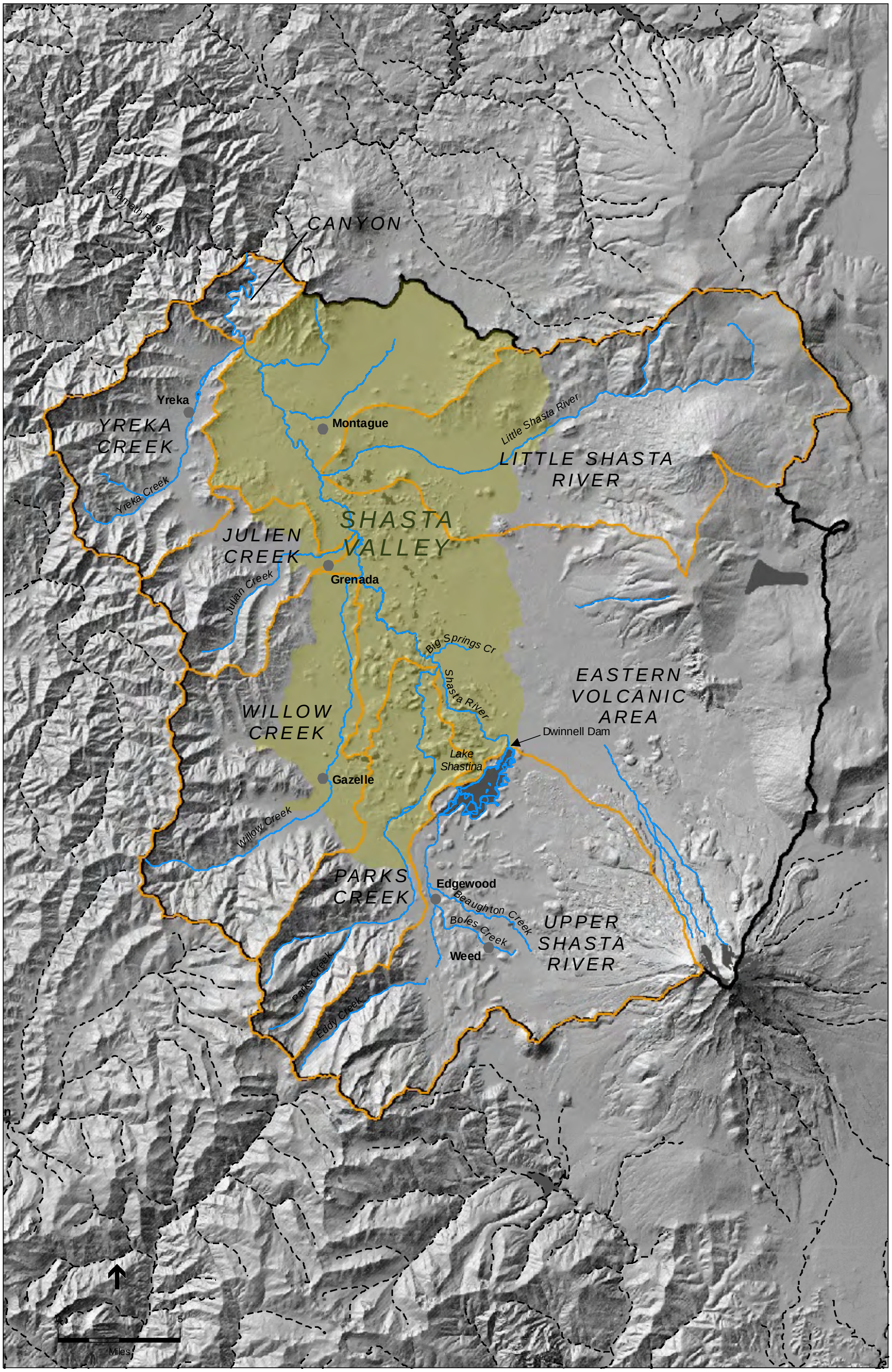
Each of the mainstem reaches and sub-watersheds contribute to geomorphic and hydrologic processes operating within the Program Area, and to the health and condition of the aquatic system. The following descriptions of the various mainstem reaches and tributary watersheds of the Shasta River are largely derived from descriptions contained in SVRCD 2005, as this represents the most comprehensive and succinct assemblage of watershed-wide information to date. The overall flow regime of the Shasta River, and changes thereto, is described from analysis of the USGS gaging record for the Shasta River near Yreka (USGS station no. 11517500).

Shasta River Watershed (General) – Shasta Valley (Shasta River from Dwinnell Dam to the Head of the Canyon)

General Morphology and Sediment Characteristics

From Dwinnell Dam to the Yreka Creek confluence, the Shasta River is approximately 32.8 miles long and is generally a meandering, low gradient and low energy system. The elevation of the channel near the base of Dwinnell Dam is 2,750 feet amsl, and the elevation of the channel at the confluence with Yreka Creek is 2,387 feet amsl (the slope of the valley is approximately 0.3 percent). This section exhibits a moderate to high sinuosity (i.e., the ratio of stream length to valley length) and contains relatively few exposed (unvegetated) bar formations.

The production and transport of sediment in the Program Area depends, in part, on natural conditions such as climate, geology, and episodic events such as flooding and landslides. However, natural stream channel processes within the watershed have been significantly altered (e.g., by Dwinnell Dam) to the point that sediment production and transport processes no longer completely support the operation of a self-sustaining geomorphic system. In addition, as discussed above, past



SOURCE: ESA (2007); modified from CalWater 2.2 dataset

Shasta River Watershed-Wide Permitting Program . 206063

Figure 3.2-4
Shasta River Subwatersheds

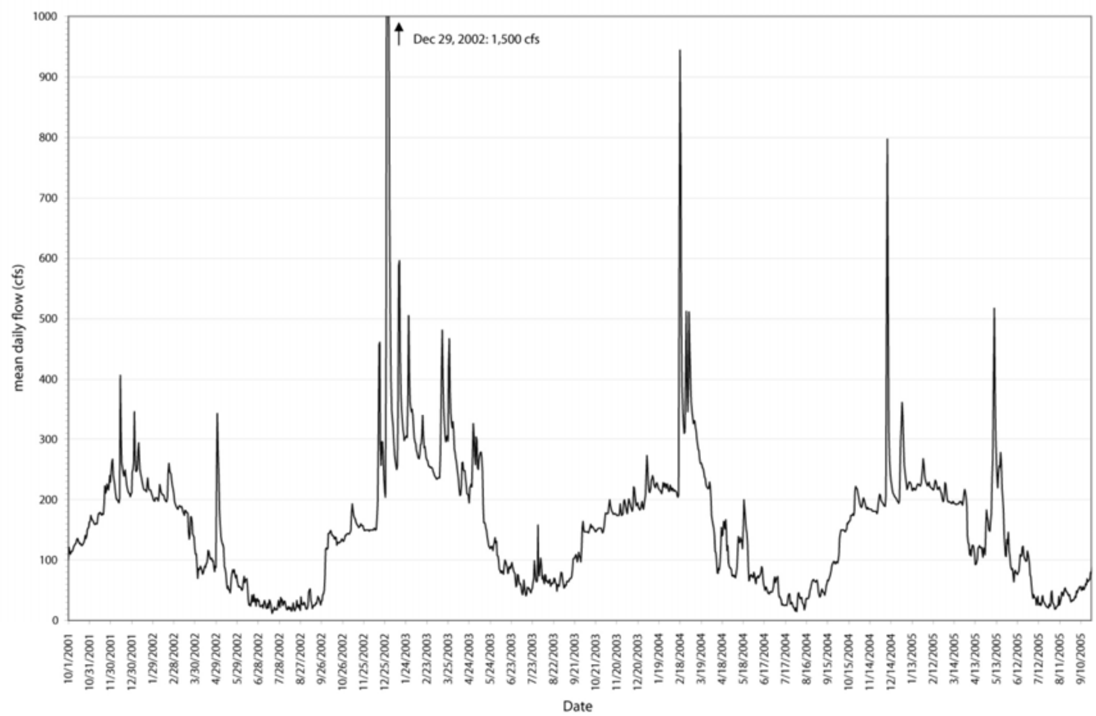
and present land-use and land management practices have increased the yield of fine sediment from certain parts of the watershed, including managed uplands, mined areas, urban developments, and degraded riparian zones. At the same time, coarse sediment is in short supply and gravels needed for channel function and aquatic habitat are not being adequately replenished. Records of various sediment-related problems can be traced back to the placer mining of the 1800s, to more recent forest management activities, and to agricultural practices. Of particular concern are excessive percentages of silt, sand, and fine gravel (particles less than 0.0625 mm and up to 6.3 mm). Excessive percentages of sediment 6.3 mm and finer can adversely affect fish species by smothering eggs and aquatic invertebrates, burying bottom cover, reducing the volume and number of pools for rearing, and, through the loss of deep, cool water pools, may result in local increases in ambient stream temperatures.

Gravels found in the reach upstream of County Road A12 provide for spawning opportunities for about half of the salmonids in the Shasta River, but these gravels are extremely vulnerable to sedimentation or complete burial from the fine sediment generated within this reach or being delivered from Parks Creek (SVRCD, 2005). Habitat surveys summarized by Ricker (1997, in NRC, 2004) and Jong (1997, in NRC, 2004) indicate that the percentage of fines in gravels is high throughout the mainstem Shasta River and Parks Creek. The fines are associated with accelerated erosion and lack of flushing flows that maintain and recruit coarse gravel (NRC, 2004). Field observations indicate that bar and streambed deposits of coarse gravel occur in upper Parks Creek and in the Shasta River upstream of Dwinnell Dam. The dam effectively traps and retains all but the finest sediment and also reduces the frequency of flows capable of periodically flushing fine sediment from any of the coarse substrate materials that remain in the channel downstream.

Surface Water Hydrology and Flow Regime

Description of the general hydrologic regime of the Shasta River is derived primarily from 72 years of record (WY 1934 through 2005) for the USGS gaging station (no. 11517500) located near the city of Yreka. The hydrograph (comprised of the mean daily flow values) from WY 2002-2005 for this station is depicted in **Figure 3.2-5**. The hydrograph shows the seasonal variability in flow of the Shasta River. Within the Valley, numerous accretions from tributaries (including Big Springs Creek, Parks Creek, Willow Creek, Julian Creek, Yreka Creek, Oregon Slough, and the Little Shasta River), springs, agricultural diversions, and return flows contribute to a complex flow regime (Deas et al., 2003).

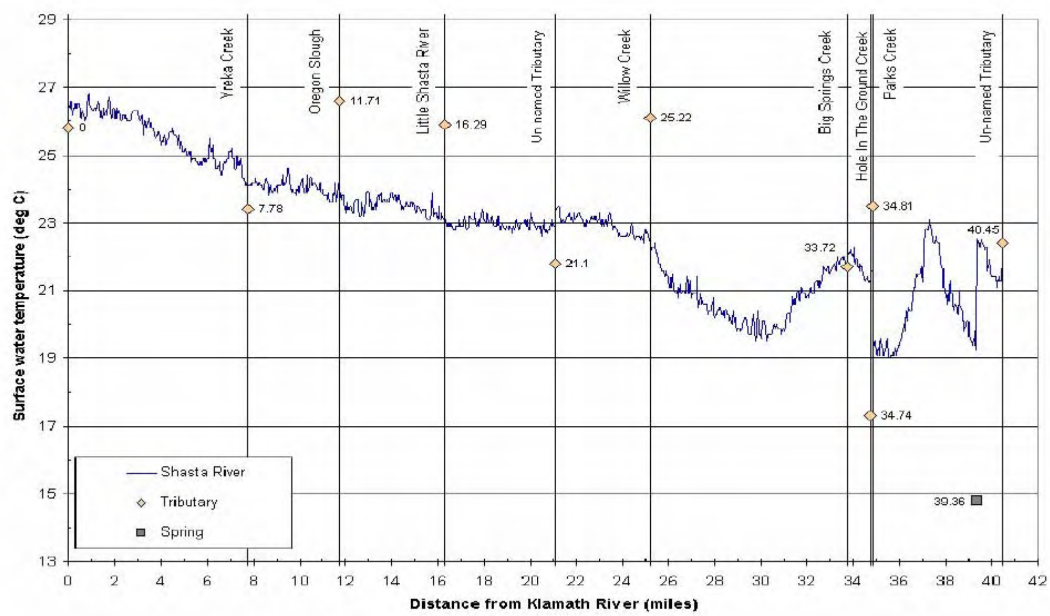
The influence of cold-water accretions (surface water and groundwater) just downstream of Dwinnell Dam, and within the Big Springs Creek area are clearly evidenced in the temperature profile of the mainstem Shasta River depicted in **Figure 3.2-6.** This temperature profile, taken on July 26, 2003, extends from the mouth of the Shasta River upstream to Dwinnell Dam. Downstream of Willow Creek, the influence of tributaries and groundwater accretions on the mainstem Shasta River temperature profile is less apparent, as the temperature tends to rise steadily down to the mouth of the Shasta River. However, in this section, the contribution of flow (surface water and groundwater) from Willow Creek and Julian Creek, as well as from other groundwater accretions, does likely contribute to stemming the rate at which Shasta River water temperatures increase moving downstream.



SOURCE: USGS (2007)

Shasta River Watershed-Wide Permitting Program . 206063

Figure 3.2-5
Shasta River Mean Daily Flows, USGS Gage No. 11517500 (WY 2002-2005)

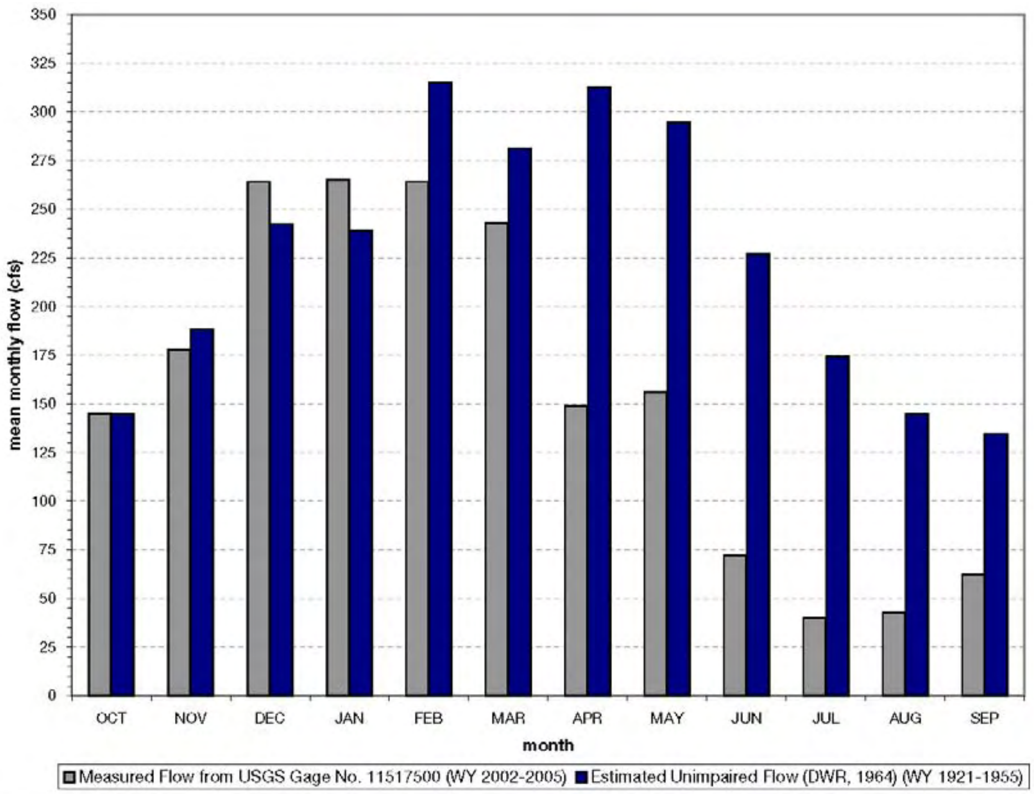


SOURCE: NCRWQCB (2006a)

Shasta River Watershed-Wide Permitting Program . 206063

Figure 3.2-6
Shasta River Longitudinal Temperature Profile (July 26, 2003)

The flow regime of the Shasta River is dominated by discharge from numerous cool-water springs and not by surface runoff (NRC, 2004). The major source area for the springs is Mount Shasta and the associated volcanic uplands to the east and south of the Shasta Valley, as well as localized areas in the Parks Creek watershed. Most of the surface runoff is generated in the uplands on the west side of Shasta Valley. Runoff peaks generally occur during the winter and late spring and are associated with rain and rain-on-snow events. Flow declines rapidly with the onset of irrigation in April, which reduces baseflow volumes during the spring and summer months. **Figure 3.2-7** depicts unimpaired flow estimates in comparison with measured flow volumes for the Shasta River. Flow slowly begins to increase in September and then spikes more dramatically beginning in October, which is when most of the seasonal irrigation diversions cease. Winter baseflow conditions typically are 180 to 200 cfs, regardless of precipitation (NRC, 2004).



NOTE: Average monthly runoff in acre-feet (DWR, 1964) converted to average monthly runoff in cubic feet per second.

Shasta River Watershed-Wide Permitting Program . 206063

SOURCE: USGS (2007); DWR (1964)

Figure 3.2-7
Shasta River Measured Flow and Estimated Unimpaired Flow

The present hydrologic regime of the Shasta River is affected by surface water diversions, groundwater pumping, and Dwinnell Dam. In the Shasta Valley upstream of County Road A12, water supplied for irrigation is approximately one-half from surface water and one-half from groundwater. Downstream of County Road A12, which covers the majority of the agricultural areas in the Shasta Valley, water supplied for irrigation is approximately one-fifth from groundwater, while the remaining acreage is irrigated with surface water (SVRCD, 2005). In this latter reach, irrigation tailwater return to the river is common and contributes to temperature gains, but at the same time is a component of instream flow (SVRCD, 2005).

Allocated diversion volumes for the mainstem Shasta River are shown in Table 3.2-1.

Groundwater Use

The exceptionally high productivity of the aquifers and the large recharge area make groundwater one of the most important and resilient resources in the Shasta Valley. However, groundwater was not part of the adjudication of water rights in the Program Area, and little is known about its influence on surface flows (NRC, 2004). Most of the surface water resources in the Program Area are fully appropriated and adjudicated. As a result, those who seek additional water for irrigation or domestic use must rely on groundwater. According to information summarized by DWR (1994), annual groundwater well installation peaked dramatically in the 1970s, leveled off in the 1980s, and has continued at a relatively steady rate up to the present. Approximately 17.9 percent of the irrigated acreage in the Program Area uses groundwater exclusively, the remaining irrigated acreage uses either surface water exclusively, or some combination of groundwater and surface water (DWR, 2006).

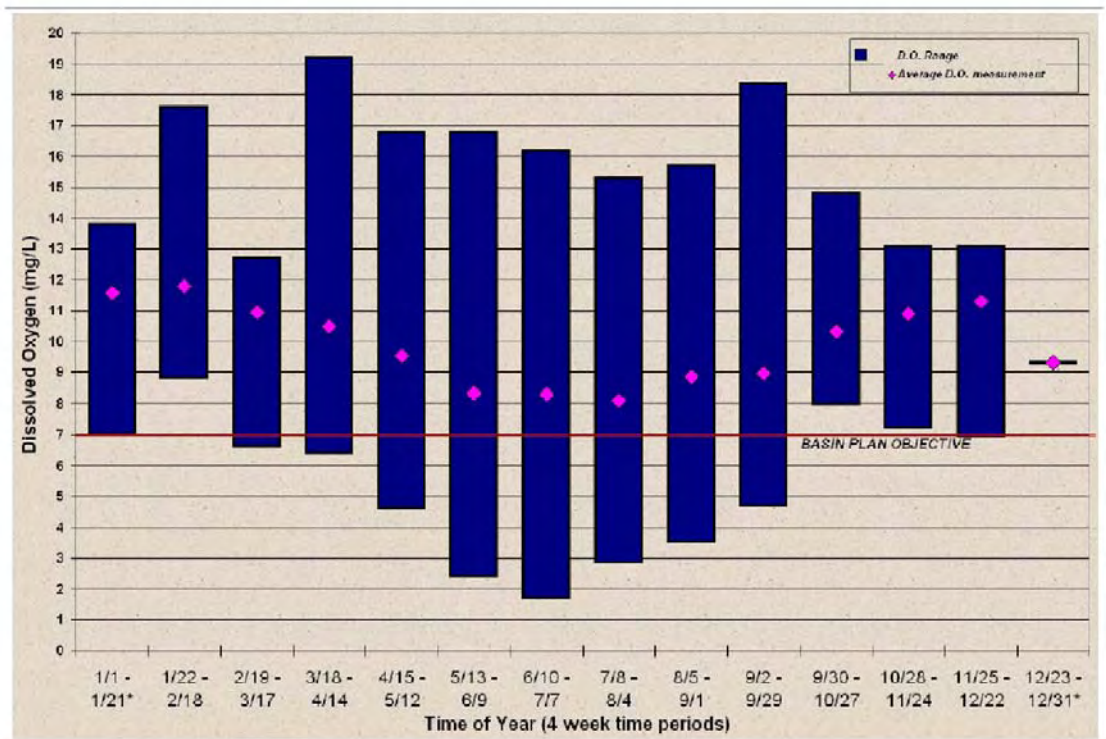
Water Quality

The NCRWQCB (NCRWQCB, 2006b) has identified water quality issues for the Shasta River related to temperature and to organic enrichment/low dissolved oxygen (e.g., high nutrient loads). In the Program Area, elevated temperatures and low dissolved oxygen contribute to the impairment of beneficial uses associated with the cold water fishery, specifically the salmonid fishery (NCRWQCB, 2006a). Potential sources for these water quality issues can be described by a few general categories: agricultural runoff, flow regulation and modification, and habitat modification (e.g., removal of riparian vegetation).

Temperature. Numerous parties have collected temperature data in the Program Area, including private landowners, the Shasta River CRMP, SVRCD, CDFG, DWR, the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (USEPA), and NCRWQCB (NCRWQCB, 2006a). Shasta River temperature data records date back to the 1930s, but intensive temperature monitoring using continuous temperature probes began in the 1990s. Figure 3.2-6 shows Shasta River temperature data presented by NCRWQCB (NCRWQCB, 2006a).

Daily water temperature fluctuations vary throughout the Program Area and may fluctuate up to 8°C (14°F) (daily) during summer months at some locations, including the mouth of the Shasta River. Daily minimum water temperatures in the lower mainstem in summer are typically greater than 20°C (68°F), and daily maximums often exceed 25°C (77°F) (NRC, 2004). The Shasta River becomes progressively cooler in the upstream direction, but temperatures remain largely suboptimal for cold water fish species for most of its length from late June through early September. The causes of high temperatures include chronic low flow due to agricultural diversions, lack of riparian shading, and addition of warm irrigation tailwater (NRC, 2004).

Dissolved Oxygen. Measurement of dissolved oxygen concentrations of the Shasta River has been conducted by numerous parties, including private landowners, the Shasta River CRMP, SVRCD, the City of Yreka, CDFG, DWR, USFWS, USEPA, and NCRWQCB (NCRWQCB, 2006a). Dissolved oxygen records date back to the 1960s, but intensive dissolved oxygen monitoring using continuous recording devices began in the 1990s. **Figure 3.2-8** shows Shasta River dissolved oxygen data as presented by NCRWQCB (2006a). The data presented in Figure 3.2-8 is a composite of all dissolved oxygen measurements for mainstem Shasta River locations over the period from 1994 to 2004.



SOURCE: NCRWQCB (2006a)
* Less than 4 weeks

Shasta River Watershed-Wide Permitting Program . 206063
Figure 3.2-8
Shasta River Dissolved Oxygen Concentrations

Dissolved oxygen concentrations[4] vary both seasonally and spatially along the mainstem Shasta River. According to the data summarized and collect by NCRWQCB (2006a), with few exceptions, mainstem Shasta River dissolved oxygen concentrations are above 7.0 milligrams per liter (mg/L) (the Basin Plan minimum objective) during the fall and winter; though dissolved oxygen concentrations fall below this value for some period of time during the summer at all locations monitored on the mainstem Shasta River (NCRWQCB, 2006a), dissolved oxygen concentrations below saturation are apparently uncommon during the day in the Shasta River, but

[4] As temperature increases, less oxygen can be dissolved in water. One hundred percent saturation for freshwater at sea level and 15°C (59°F) is around 10.1 mg/L, at 20°C (68°F) it is approximately 9 mg/L, and at 25°C (77°F) it is around 8.3 mg/L (SWRCB, 2004).

where they occur, they coincide with high temperatures and low flows (Campbell, 1995, and Gwynne, 1993, in NRC, 2004).

Growth and development of the different life stages of salmon are impacted by reductions in the water's dissolved oxygen concentration. Reductions can affect fitness and survival by altering embryo incubation periods, decrease the size of fry, increase the likelihood of predation, and decrease feeding activity (SWRCB, 2004). In juveniles and adults it can impact their ability to swim, feed, and reproduce. In salmonid embryo and larval stages, no production impairment occurs at a dissolved oxygen concentration of 11 mg/L in the water column and an intragravel concentration of 8 mg/L (assumes a 3mg/L DO concentration loss between the surface water and gravels) (USEPA, 1986). As the dissolved oxygen concentration drops, a slight production impairment occurs in the water column at 9 mg/L and an intragravel concentration 6 mg/L, and severe production impairment occurs at 7 mg/L in the water column and 4 mg/L for the intragravel concentration. Juvenile and adult salmonids show no production impairment at concentrations of 8 mg/L, a slight impairment at 6 mg/L, and severe impairment when concentrations reach 4 mg/L. Most fish will not survive when the dissolved oxygen concentration is below 3 mg/L.

Water quality issues have also been examined and summarized for Lake Shastina (Vignola and Deas, 2005). In general, Lake Shastina has had and continues to experience water quality problems as a result of eutrophication.[5] The nutrient levels and algal assemblages in Lake Shastina are typical of eutrophic waters that are generally under-saturated with regards to dissolved oxygen. CDFG (1964a, 1964b, 1965a, 1965b, 1969, 1975, 1979, and 2001, *as cited in* Vignola and Deas, 2005) has reported on various water quality conditions and fish kills at Lake Shastina. Identified problems that potentially lead to fish die-off included elevated temperatures, low dissolved oxygen levels or anoxia, algal blooms, elevated ammonia, and elevated pH levels.

The Impact of Diversions on Flow Volume and Water Quality

As discussed above, water diversions have led to decreased surface flows in the spring and summer months, thereby reducing the amount of instream habitat and locally increasing ambient surface water temperatures. As part of the Program, CDFG would authorize the take of coho salmon that might occur incidental to diverting and using water pursuant to and in accordance with a valid water right (ITP Covered Activity 1). All water diversions are existing, ongoing diversions, both active and passive. NRC (2004) has concluded that the adjudication of surface waters under the Shasta River Decree, as currently administered, is insufficient to supply the quantity and quality of water necessary to sustain salmonid populations in the Program Area. Further, and more specifically, NCRWQCB (2006a) has concluded that elevated temperatures and low dissolved oxygen contribute to the non-attainment of beneficial uses associated with the cold-water fishery, namely the salmonid fishery. This is the existing condition within the Program Area. Over time, the persistence of unnaturally low baseflow volumes can exert an effect over an increasingly

[5] Eutrophication is the process whereby a water body receives an excess of nutrients (usually nitrogen and phosphorous) that subsequently stimulate excessive plant and algal growth. This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.

larger area, such as adversely affecting the condition of the riparian corridor (e.g., lowering the streamside water table, loss of stabilizing vegetation, and subsequent increased rates of bank erosion and channel incision during high-flow periods). These effects can be further exacerbated by an increase in the rate of water diversion or extraction.

Implementation of the Program would not cause Agricultural Operators to increase their surface water diversions or increase the amount of water they are entitled to divert. To the contrary, the Program, by means of a number of required measures, would provide a mechanism to verify, monitor, and control the diversion and use of water within the Program Area to ensure that such diversion and use is based on a valid water right.

Lower Shasta River (Canyon Reach)

The lower portion of the Program Area (downstream of the confluence of Yreka Creek and the Shasta River) has an area of approximately 9.2 square miles and comprises about 1 percent of the entire Program Area. This reach of the Shasta River is approximately 7.7 miles in length. The elevation of the channel ranges from 2,387 feet amsl at the Yreka Creek confluence to 2,020 feet at the confluence with the Klamath River (the mouth of the Shasta River). This reach of the Shasta River is steep and surrounded by high, steeply sloping, rugged mountains. The channel winds down to the Klamath River in large meanders cut into, and confined by, bedrock. In many places in the canyon section, the highway alignment required deep cuts across and into the steep valley slopes. These steep cut slopes are especially susceptible to erosion and are responsible for contributing a large volume of fine sediment to the river (Ayres Associates, 1999). The canyon section of the lower Shasta River is a cobble-boulder bed channel that contains several cobble-boulder riffles and intermittent bedrock outcrops. Historically, gravel was supplied to this reach from Yreka Creek, but channelization, capture of flood flows, and stream incision associated with mining in the Yreka Creek watershed have substantially reduced the natural sediment supply. As a result, the lack of gravel and cobbles in the lower gorge of the Shasta River reflects a greatly reduced sediment supply (Ayres Associates, 1999).

Upper Shasta River (upstream of Dwinnell Dam)

The upper portion of the Program Area (upstream of Dwinnell Dam) has an area of approximately 127 square miles and comprises about 16 percent of the entire Program Area; this reach of the Shasta River is approximately 17.8 miles in length. The headwater elevations of this portion of the watershed range from 14,162 feet amsl (Mount Shasta) to 9,025 feet amsl (Mount Eddy), while in the lowland valley portion the elevation reduces to a minimum of 2,750 feet amsl at the base of Dwinnell Dam. This area experiences relatively high annual precipitation, both as rain and snow. Runoff from the Eddy Mountains (to the southwest) is predominately surface flow, while Mount Shasta (to the southeast) provides a large source of spring flow to the channels emerging from its flanks in the southeast portion of the watershed. Thus, flows in Dale Creek, Eddy Creek, and the Shasta River can be flashy, while flows in the predominately spring-fed creeks (Boles Creek, Beaughton Creek, and Carrick Creek) tend to be less variable and provide reliable baseflow in both wet and dry years (SVRCD, 2005). In addition to the water flowing down the Parks Creek bypass, Dwinnell Dam captures flow from the upper Shasta River watershed.

Although the Pleistocene debris avalanche deposit underlies most of this portion of the Program Area, it has been overlain by more recent materials including granitic and metamorphic sediment from the Franciscan highlands in the Mount Eddy area and more recent volcanic materials eroded from Mount Shasta and the volcanic terrain to the southeast. Because of comparatively high gradients and abundant streamflow, gravels are readily transported downstream until they reach the large flat area now occupied by Lake Shastina. This was reportedly the downstream end of gravel deposition prior to construction of Dwinnell Dam (SVRCD, 2005).

Allocated diversion volumes for the upper Shasta River and tributaries within this portion of the watershed are summarized in Table 3.2-1.

Parks Creek

The Parks Creek watershed drains an area of approximately 55 square miles to the west of the City of Weed and comprises about 7 percent of the entire Program Area; Parks Creek (including the West Fork) is approximately 23.3 miles in length. Parks Creek originates on China mountain (at a peak elevation of 8,542 feet amsl), flows east down to the Valley, and then turns and winds northeast to its confluence with the Shasta River near RM 35 (at an elevation of 2,590 feet amsl). Parks Creek has its headwaters in terrain dominated by historic glacial formation processes; from the glaciated valleys of the headwaters it transitions slowly to flat and broad alluvial fans which have formed wetlands in the lower 3 to 4 miles of the stream (SVRCD, 2005). In its lowest 10 miles, Parks Creek crosses through the debris avalanche deposits.

Parks Creek varies from a deeply incised stream with high banks in its upper reaches to a low-banked, meandering stream well connected to the surrounding landscape in its lower reaches. Flow in Parks Creek is flashy in the winter and spring due to rain-on-snow events, while substantial summer base flow is provided by numerous springs scattered along its length (SVRCD, 2005). During the summer, surface flow is intermittently lost in some reaches of Parks Creek (KRIS, 2007) while other reaches maintain year-round flow due to the influence of springs. Parks Creek is the only stream still connected to a headwater area capable of generating frequent flood events. Other similar tributaries are either disconnected from the Shasta River by Dwinnell Dam or receive too little precipitation to generate significant flows (SVRCD, 2005). Coupled with significant coarse and fine sediment supply in its headwater areas, this means that Parks Creek is capable of moving substantial amounts of sediment. However, much of this coarse sediment load is deposited in the flat, lower reaches of Parks Creek and there is little or no evidence of bedload transport to the mainstem Shasta River.

Due to the influence of snowmelt and springs, Parks Creek may have formerly contributed valuable cold water to the Shasta River during summer months. However, recent investigations suggest that cold water areas in the lower reach of the creek are found only in proximity to springs, and the water delivered to the Shasta River can be quite warm (SVRCD, 2005).

Agricultural activity is focused primarily on pasture for cattle, and most of the irrigation practices make use of surface water. Substantial winter and spring flows from Parks Creek are diverted into the Shasta River for storage at Dwinnell Dam, thereby reducing the natural source of coarse sediment supply to downstream reaches. Although Parks Creek is a gravel- and cobble-bedded stream at the point of diversion, it has now been identified as a significant source of fine sediment to the middle and lower Shasta River (LaPlante, 2001). Irrigation tailwater return is known to occur in this watershed and is believed to be contributing to elevated water temperatures in Parks Creek (SVRCD, 2005). In addition, the lower 15 miles of Parks Creek has areas of significant and long-standing livestock impacts resulting in increased sedimentation and decreased shade.

Allocated diversion volumes for Parks Creek and its tributaries are summarized in Table 3.2-1.

Yreka Creek

The Yreka Creek watershed drains an area of approximately 52 square miles surrounding the City of Yreka and comprises about 6.5 percent of the entire Program Area. The creek is approximately 12 miles in length. Elevations within this watershed range from 5,810 feet amsl along its western divide (with the Scott Valley) to 2,387 feet amsl at the confluence with the Shasta River. General characteristics of Yreka Creek vary from steep and deeply incised in its upper reaches to a near-surface stream in its alluvial lower reaches (SVRCD, 2005). Through the City of Yreka the creek has been altered and partially channelized. Downstream of Yreka, the creek’s floodplain was completely overturned by dredge mining prior to the early 1940s (SVRCD, 2005). Subsequently, in the 1950s, the dredge tailings were leveled and Yreka Creek was relocated to a newly constructed channel at the base of the hills bordering the eastern edge of the historic floodplain (SVRCD, 2005).

Irrigation diversions capture the available water in the headwater reaches of Yreka Creek (SVRCD, 2005). The Greenhorn Reservoir, owned by the City of Yreka and used for recreational purposes, captures runoff from Greenhorn Creek, a principal tributary to Yreka Creek. Underflow of both Yreka Creek and Greenhorn Creek is also used for domestic and irrigation purposes (SVRCD, 2005). Surface flows are maintained in Yreka Creek through the summer as a result of releases from Greenhorn Reservoir, and sub-surface inflows below the Yreka Wastewater Treatment Plant (KRIS, 2007).

Allocated diversion volumes for Yreka Creek and its tributaries are summarized in Table 3.2-1.

Julian Creek and Willow Creek

Julian Creek and Willow Creek drain much of the remainder of the westside of the Program Area between the Parks Creek watershed to the south and the Yreka Creek watershed to the north. The Julian Creek watershed is 33.8 square miles in extent (4.2 percent of the Program Area); the Willow Creek watershed is 89.4 square miles in extent (11.2 percent of the Program Area). Both of these creeks have their headwater areas among very old igneous and sedimentary rock formations, and both emerge onto the gently sloping debris avalanche deposit of the Shasta Valley. Compared to the eastside of the Program Area, where percolation of rain and snow through porous volcanic rock formations dominates the runoff process, runoff from these uplands on the westside is predominantly surface flow. Julian Creek is unique in being the only tributary that flows across the debris avalanche deposit yet is capable of delivering coarse sediment to the Shasta River. Most years, however, this watershed generates little overland flow and significant amounts of coarse materials are only delivered during very large flood events (SVRCD, 2005). Much of the length of these tributaries is dry by mid-summer (SVRCD, 2005).

Allocated diversion volumes for Willow Creek and its tributaries are summarized in Table 3.2-1.

Little Shasta River

The Little Shasta River drains an area of approximately 131 square miles, comprising about 16 percent of the entire Program Area. The Little Shasta River is approximately 26 miles long, and flows through the northeast portion of the Program Area. Elevations within this watershed range from 8,241 feet amsl at Goose Nest to 2,471 feet amsl at the confluence with the Shasta River (SVRCD, 2005). The Little Shasta River watershed consists of Cascade volcanic terrain in its headwater area, a steep constrained canyon along its middle reaches, and dry flatlands along its lower reaches, where the influence of the ancient debris avalanche predominates. Similar to Parks Creek, the Little Shasta River deposits most of its coarse sediment load within the Valley prior to reaching the Shasta River. Flow can be flashy in the winter and spring, though the highly porous soils, the relatively low elevation, and the modest amount of precipitation within this watershed all tend to minimize runoff (SVRCD, 2005). Substantial summer baseflow is provided by numerous springs in the headwater areas and other springs concentrated near RM 13 (SVRCD, 2005). The numerous diversions on the Little Shasta River routinely dewater the channel in late summer (NRC, 2004).

Agricultural activities in the Little Shasta River watershed are primarily cow-calf operations, with land used for dryland and irrigated pasture, production of grass and alfalfa, and production of small grains for livestock feed. Allocated diversion volumes for the Little Shasta River and its tributaries are summarized in Table 3.2-1.

Eastern Volcanic Area and Big Springs Creek

The eastern volcanic area sub-watershed refers to the vast area to the east of the Shasta River between the upper Shasta River watershed and the Little Shasta River watershed. The geology of this area is dominated by recent lava (mainly basalt) flows emanating from Mount Shasta, and to a lesser degree by older (i.e., late Pleistocene and Tertiary) lava flows in its northern portion. Most of the eastern streams that cross the lava flows of the high Cascades normally do not maintain surface flow as far west as Shasta Valley, owing to the porous nature of the lava (Mack, 1960). Concerning the Program, the dominant hydrologic feature of this sub-watershed is Big Springs Creek. During summer months Big Springs Creek inflow accounts for up to 50 percent of the flow in the Shasta River downstream of Big Springs Creek (NCRWQCB, 2006a).

As summarized by SVRCD (2005):

> Big Springs Creek (along with its only tributary, Little Springs Creek) presents the most visibly important component of the entire Shasta River as its major source of cold water in summer. While less visible, the entire area around Big Springs, the lower end of Parks Creek, and for several miles upstream/downstream of the Big Springs Creek confluence the area is dotted with springs, named and unnamed, that collectively create nearly all the

instream flow of the Shasta in the summer. In this area ground water apparently originating from the porous volcanic slopes of Mt. Shasta, Whaleback and Herd Peak encounter the relatively impermeable volcanic debris flow deposits, and are forced to the surface, discharging at approximately 56-58°F (13-14°C) year round. In addition to high quality water, gravels are also located in large patches in this portion of the reach, and present substantial spawning areas.

Historically flows at the mouth of Big Springs Creek were apparently on the order of 100 to 120 cfs, and were largely unaffected by climatic variability. Unfortunately, lack of access to this entire area for scientific investigation severely limits the ability to report directly on current conditions.[6]

Conclusions Regarding Hydrologic and Geomorphic Setting for the Shasta River Watershed

Past and present human activity and development have substantially altered the hydrologic and geomorphic conditions within the Program Area. The most important detrimental land uses have been timber harvesting and related road construction, fire suppression, beaver removal, mining and dredging, channel modification and flood control, agricultural practices, and the construction of Dwinnell Dam. The principal impacts of these human actions have been an altered channel structure, an altered flow regime, and disruption of sediment transport processes. Some of these impacts may be essentially irreversible or infeasible to change (e.g., Dwinnell Dam); others can be partially alleviated or even completely repaired in some cases (e.g., enhancement of the riparian corridor). Most of the lasting impacts observed today are the collective result of multiple actions and land management decisions, and it is often difficult to “tease out” the relative influence of any one particular action. Nevertheless, it is important to understand that historical or continuing practices such as flow regulation, channel modification, and grazing can affect contemporary river characteristics for decades, or longer.

3.2.2 Regulatory Setting

Federal and State Water Quality Policies

The statutes that govern the activities under the Program that affect water quality aspects are the federal Clean Water Act (CWA) (33 U.S.C. § 1251) and the Porter-Cologne Water Quality Control Act (Porter-Cologne) (Water Code, § 13000 *et seq.*). These acts provide the basis for water quality regulation in the Program Area.

The California Legislature has assigned the primary responsibility to administer and enforce statutes for the protection and enhancement of water quality to the SWRCB and its nine Regional Water Quality Control Boards (RWQCB). The SWRCB provides state-level coordination of the water quality control program by establishing statewide policies and plans for the implementation of state and federal regulations. The nine RWQCBs throughout California adopt and implement

---

6 Recently, access to perform hydrologic studies has been granted in parts of the Big Springs Creek area. Flow monitoring began on Big Springs creek in the spring of 2008; the data collected to date is preliminary and subject to approval and quality assurance by those parties collecting and analyzing the data.

water quality control plans that recognize the unique characteristics of each region with regard to natural water quality, actual and potential beneficial uses, and water quality problems. The RWQCB adopts and implements a Water Quality Control Plan (hereinafter Basin Plan) that designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the plan (California Water Code, §13240-13247).

Corps Permit and Water Quality Certification

CWA section 404 requires a permit from the United States Army Corps of Engineers (Corps) prior to discharging dredged or fill material into waters of the United States, unless such a discharge is exempt from CWA section 404. The term "waters of the United States" as defined in the Code of Federal Regulations (40 CFR 230.3[s]) includes all navigable waters and their tributaries. In addition, section 401 of the CWA requires that an applicant for any federal permit (e.g., a Corps 404 permit) obtain certification from the state that the discharge will comply with other provisions of the CWA and with state water quality standards. For the Program Area, NCRWQCB or the SWRCB (in the case of activities associated with water diversions) must provide the water quality certification required under section 401 of CWA. It is up to the individual project proponent, in this case the sub-permittees and SVRCD, to contact the federal agency(s) in order to determine whether the federal agency(s) would take jurisdiction on a specific project and require a permit; if a federal permit is required then the project proponent would also be required to obtain water quality certification from NCRWQCB.

Beneficial Use and Clean Water Act Section 303(d)

NCRWQCB is responsible for the protection of the beneficial uses of waters within Siskiyou County. NCRWQCB uses its planning, permitting, and enforcement authority to meet this responsibility and has adopted the Water Quality Control Plan for the North Coast Region (Basin Plan) to implement plans, policies, and provisions for water quality management. NCRWQCB published the most recent version of the Basin Plan in September 2006 (NCRWQCB, 2006c).

In accordance with state policy for water quality control, NCRWQCB employs a range of beneficial use definitions for surface waters, groundwater basins, marshes, and mudflats that serve as the basis for establishing water quality objectives and discharge conditions and prohibitions. The Basin Plan (NCRWQCB, 2006c) has identified existing and potential beneficial uses supported by the key surface water drainages throughout its jurisdiction. The beneficial uses designated in the Basin Plan for the water bodies relevant to the Program are identified in **Table 3.2-2**. The applicable beneficial use categories are defined in **Table 3.2-3**. The Basin Plan (NCRWQCB, 2006c) also includes water quality objectives for each of the identified beneficial uses.

The objective of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." Under CWA section 303(d), the State of California is required to develop a list of impaired water bodies that do not meet water quality standards and objectives. A statewide list of impaired water bodies was first established in 1998, and subsequently has been updated to include more recent information and new pollutants.

TABLE 3.2-2
BENEFICIAL USES IN THE SHASTA VALLEY HYDROLOGIC AREA

Waterbody	MUN[a]	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	WILD	RARE	MIGR	SPWN	AQUA
Shasta River & Tributaries	E	E	E	P	E	E	E	P	E	E	E	E	E	E	E	E	E	E
Lake Shastina	P	E	P	P	E	E	E		E	E		E	E	E		P		P
Lake Shastina Tributaries	E	E	E	P	E	E	P	P	E	E	E	E	E	E		E	E	P

E = existing beneficial use
P = potential beneficial use

[a] Refer to Table 3.2-3, below, for definition of abbreviations

SOURCE: NCRWQCB (2006c)

Table 3.2-4 provides details of the listing of the Shasta River as an impaired water body, as designated by NCRWQCB (2006b), including pollutants and issues of concern. For those water bodies failing to meet standards, states are required to establish total maximum daily loads (TMDL). A TMDL defines how much of a specific pollutant a given water body can tolerate and still meet relevant water quality standards. The Shasta River has been listed as impaired because of temperature and dissolved oxygen levels in excess of (or in the case of dissolved oxygen, below) water quality standards described in the CWA or in the Basin Plan. In the Program Area, elevated temperatures and low dissolved oxygen contribute to the non-attainment of beneficial uses associated with the cold water fishery, specifically the salmonid fishery (NCRWQCB, 2006a). Water quality standards concerning Shasta River temperature and dissolved oxygen levels have also been identified in the Basin Plan (NCRWQCB, 2006c). The standards stipulate that the natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the RWQCB that such alteration in temperature does not adversely affect beneficial uses, and at no time or place shall the temperature of any "cold" water be increased by more than 2.8°C (5°F) above the natural receiving water temperature. Further, the standards state that the minimum dissolved oxygen level for the Shasta River (and other streams within the Program Area) is 7.0 mg/L and the 50 percent lower limit[7] is 9.0 mg/L.

The Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads was published in June of 2006 (Shasta River TMDL; NCRWQCB, 2006a). In general, this document identifies and describes the causes of impairment and recommends specific actions and implementation measures in order to achieve the water quality standards set forth in the Basin Plan. To help reduce ambient stream temperatures in the

[7] Fifty percent upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. Fifty percent or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.

TABLE 3.2-3
DEFINITIONS OF BENEFICIAL USES OF SURFACE WATERS

Beneficial Use	Description
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
Agricultural Supply (AGR)	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
Industrial Service Supply (IND)	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.
Industrial Process Supply (PRO)	Uses of water for industrial activities that depend primarily on water quality.
Groundwater Recharge (GWR)	Uses of water for natural or artificial recharge or groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.
Freshwater Replenishment (FRSH)	Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).
Navigation (NAV)	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.
Hydropower Generation (POW)	Uses of water for hydropower generation.
Water Contact Recreation (REC 1)	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, or use of natural hot springs.
Non-Contact Water Recreation (REC 2)	Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Commercial and Sport Fishing (COMM)	Uses of water for commercial, recreational (sport) collection of fish, shellfish, or other aquatic organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
Warm Freshwater Habitat (WARM)	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Cold Freshwater Habitat (COLD)	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat (WILD)	Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Rare, Threatened, or Endangered Species (RARE)	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal laws as rare, threatened, or endangered.
Migration of Aquatic Organisms (MIGR)	Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.
Spawning, Reproduction, and/or Early Development (SPWN)	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.
Aquaculture (AQUA)	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

SOURCE: NCRWQCB (2006c)

TABLE 3.2-4
PROPOSED 2006 CWA SECTION 303(D) LIST OF WATER QUALITY LIMITED SEGMENTS IN THE PROGRAM AREA

Name	Pollutant/Stressor	Source	TMDL Completion Date
Shasta River	Organic Enrichment / Low Dissolved Oxygen	• Minor Municipal Point Source • Agriculture – storm runoff • Agriculture – irrigation tailwater • Dairies • Hydromodification • Dam Construction • Flow Regulation/Modification • Habitat Modification	Staff Report for the Action Plan published on June 28, 2006
	Temperature	• Agriculture – irrigation tailwater • Flow Regulation/Modification • Habitat Modification • Removal of Riparian Vegetation • Drainage/Filling of Wetlands	Staff Report for the Action Plan published on June 28, 2006

SOURCE: NCRWQCB (2006b)

Shasta River, NCRWQCB (2006a) has identified temperature loading allocations for tailwater return flow and instream surface flows. In terms of tailwater return, NCRWQCB (2006a) calls for no net increase in receiving water temperature; for surface water flows, NCRWQCB (2006a) calls for reductions in the maximum daily stream temperature, by means of an increase and dedication of cold-water instream flow, of 1.5°C (2.7°F), 1.2°C (2.2°F), and 2.1°C (3.8°F) at RM 24.1, RM 15.5, and RM 5.6, respectively. Through modeling exercises that also incorporate and simulate additional improvement measures (including increased shading through riparian vegetation restoration), NCRWQCB (2006a) has concluded that satisfying the above criteria would result in a decrease in the ambient water temperature of the Shasta River and attainment of the temperature component of the cold-water beneficial use. In addition, to help increase dissolved oxygen levels in the Shasta River the NCRWQCB (2006a) has also identified a nitrogenous oxygen demand (NBOD) loading allocation of 0.85 mg/L for tailwater return flows.

NPDES Program

The CWA was amended in 1972 to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The 1987 amendments to the CWA added section 402(p), which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES Program. In November 1990, USEPA published final regulations that establish storm water permit application requirements for discharges of storm water to waters of the United States from construction projects that encompass five or more acres of soil disturbance. Regulations (Phase II Rule) that became final on December 8, 1999, expanded the existing NPDES Program to address storm water discharges from construction sites that disturb land equal to or greater than one acre and less than five acres (small construction activity) (SWRCB, 1999).

While federal regulations allow two permitting options for storm water discharges (individual permits and General Permits), SWRCB has chosen to adopt only one statewide General Permit at this time that would apply to all storm water discharges associated with construction activity.[8] This General Permit requires all dischargers where construction activity disturbs one acre or more, to:

- Develop and implement a Storm Water Pollution Prevention Plan (SWPPP) which specifies Best Management Practices (BMPs) that would prevent all construction pollutants from contacting storm water and with the intent of keeping all products of erosion from moving off site into receiving waters.
- Eliminate or reduce non-storm water discharges to storm sewer systems and other waters of the nation.
- Perform inspections of all BMPs.

This General Permit is implemented and enforced by the nine RWQCBs. NCRWQCB administers the stormwater permitting program in the section of Siskiyou County that includes the Program Area. Dischargers are required to submit a Notice of Intent (NOI) to obtain coverage under this General Permit and annual reports identifying deficiencies of the BMPs and how the deficiencies were corrected. Dischargers are responsible for notifying the relevant RWQCB of violations or incidents of non-compliance.

On August 19, 1999, SWRCB reissued the General Construction Storm Water Permit (Water Quality Order 99-08-DWQ, referred to as “General Permit”). In September 2000, a court decision directed SWRCB to modify the provisions of the General Permit to require permittees to implement specific sampling and analytical procedures to determine whether BMPs implemented on a construction site are: (1) preventing further impairment by sediment in storm waters discharged directly into waters listed as impaired for sediment or silt, and (2) preventing other pollutants that are known or should be known by permittees to occur on construction sites and that are not visually detectable in storm water discharges from causing or contributing to exceedances of water quality objectives. The monitoring provisions in the General Permit have been modified pursuant to the court order.

As part of the Program, if a Covered Activity performed at a single project location will disturb a total of one acre or more of land, then SVRCD or the Agricultural Operator performing the activity will be required to submit a NOI to SWRCB and obtain coverage under the General Permit. The preparation of a SWPPP would be required in accordance with the General Permit. The SWPPP would include, but not be limited to, relevant measures, conditions, and obligations already described as part of the Program which would reduce the impacts of construction activities on stormwater and receiving water quality and quantity.

[8] SWRCB Order No. 99-08-DWQ National Pollutant Discharge Elimination System General Permit No. CAS000002.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Act (codified in the California Water Code, §13000 *et seq*.) is the basic water quality control law for California. As mentioned above, it is implemented by SWRCB and the nine RWQCBs. SWRCB establishes statewide policy for water quality control and provides oversight of RWQCBs' operations. RWQCBs have jurisdiction over specific geographic areas that are defined by watersheds. Siskiyou County is under the jurisdiction of NCRWQCB. In addition to other regulatory responsibilities, RWQCBs have the authority to conduct, order, and oversee investigation and cleanup where discharges or threatened discharges of waste to waters of the state[9] could cause pollution or nuisance, including impacts to public health and the environment.

Dredge/Fill Activities and Waste Discharge Requirements

Covered Program Activities that involve or are expected to involve dredge or fill, and discharge of waste, are subject to water quality certification under section 401 of the CWA and/or waste discharge requirements under the Porter-Cologne Act. SWRCB's Division of Water Rights processes section 401 water quality certifications on projects that involve water diversions (California Code of Regulations, title 23, § 3855). Chapter 4, Article 4 of the Porter-Cologne Act (California Water Code, § 13260-13274), states that persons discharging or proposing to discharge waste that could affect the quality of waters of the state (other than into a community sewer system) shall file a Report of Waste Discharge with the applicable RWQCB. For discharges directly to surface water (waters of the United States) an NPDES permit is required, which is issued under both state and federal law; for other types of discharges, such as waste discharges to land (e.g., spoils disposal and storage), erosion from soil disturbance, or discharges to waters of the state (such as isolated wetlands), Waste Discharge Requirements (WDRs) are required and are issued exclusively under state law. The WDR application process is generally the same as for CWA section 401 water quality certification, though in this case it does not matter whether the particular project is subject to federal regulation. The project proponent would contact the NCRWQCB, who would determine whether WDRs or a waiver of WDRs is required.

State Regulation and Oversight of Water Rights

SWRCB regulates the diversion and use of water in California, in part by the issuance of permits and licenses. In general, under state law, a person may divert and use water under a riparian or appropriative right. A riparian right entitles the landowner to use a correlative share of the water flowing past his or her property. Riparian rights do not require permits, licenses, or government approval, but they apply only to the water which would naturally flow in the river (or stream or creek), and they may only be exercised on the property adjacent to the stream. Further, riparian rights do not entitle a water user to divert water to storage in a reservoir for use in the dry season or to use water on land outside of the watershed that comprises the diversion location. Riparian

[9] "Waters of the state" are defined in the Porter-Cologne Act as "any surface water or groundwater, including saline waters, within the boundaries of the state" (California Water Code, § 13050 (e)).

rights remain with the property when it changes hands, although parcels severed from the adjacent water source generally lose their right to the water.

An appropriative water right allocates a given rate and/or volume of water to a specific entity or user. In California, appropriative water rights are generally described as pre-1914 and post-1914 rights. For pre-1914 rights, water rights could be acquired simply by taking and beneficially using water, and also (e.g., after 1872) through establishing a priority of right by posting a notice of appropriation at the proposed point of diversion and recording the notice with the respective County Recorder (SWRCB, 1990). Regardless of the amount of water claimed in the original notice of appropriation or at the time diversion and use first began, the amount of water which can now be rightfully claimed under an appropriative right initiated prior to December of 1914 is essentially fixed by that amount which is being put to beneficial use. Persons diverting water under riparian or pre-1914 claims of right, with certain exceptions, are required to file a Statement of Water Diversion and Use with SWRCB (SWRCB, 1990).

For post-1914 appropriative rights, an application for appropriation of water is submitted to SWRCB, and SWRCB issues permits and/or licenses that govern the beneficial use and diversion and/or storage of water from surface streams, other surface bodies of water, or from subterranean streams flowing in known and definite channels. An appropriation of such water requires compliance with the provisions of Division 2, Part 2, of the California Water Code. Under post-1914 appropriation law, anyone intending to divert water from surface waters or subterranean streams, in order to 1) use on land which is not riparian to the source, 2) store in a reservoir for later use on either riparian or non-riparian lands, or 3) make use of water which would not naturally be in the source, must apply with SWRCB for a permit or small domestic use registration. Aside from the requested amount of water, an application, and the subsequent permit or license (if issued), typically specifies the purpose of use (e.g., irrigation, recreation, fish and wildlife enhancement, etc.), the place of use, and the point(s) of diversion. In order for SWRCB to approve an application, unappropriated water must be available to supply the applicant (e.g., water in many streams, including the Shasta River and its tributaries, has already been fully appropriated during the dry season of the year). Although pre- and post-1914 appropriative rights are similar, post-1914 rights are subject to a much greater degree of scrutiny and regulation by SWRCB. Riparian rights, which usually are inherent in ownership of parcels that border or span streams and rivers, still have a higher priority than appropriative rights. In order for an appropriative or riparian claim to ripen into a prescriptive right, the use must be continuous and uninterrupted for a period of five years (SWRCB, 1990).

In certain cases, use of water does not require an appropriative water right permit or a small domestic use registration. SWRCB does not have permitting authority over the use of groundwater unless it is the underflow of a surface stream or otherwise is flowing in a subterranean stream with a known and definite channel. Further, a permit is not required for the proper exercise of a riparian right or the diversion of surface water under pre-1914 claims of right. However, as mentioned above, diverters are required to file a Statement of Water Diversion and Use with SWRCB.[10]

[10] See California Water Code, § 5101.

In particular circumstances (e.g., when stream systems have a proportionately large amount of diversions, or the system is seemingly over-allocated and the priority of right amongst diverters is in question or disputed), SWRCB may determine all rights to water in a given stream system whether based upon appropriation, riparian right, or other basis of right. Such a determination ultimately takes the form of a legal report often referred to as an adjudication and/or decree, as with the 1932 Shasta River Decree. The process is initiated by one or more claimants (e.g., diverters) formally requesting that a determination of rights be made by SWRCB for a given stream system; SWRCB then determines whether or not such a determination of rights is warranted and, if so, proceeds with the process of quantifying water allocations and priorities of right. Ultimately, such a decree sets forth the priority, amount, season of use, purpose of use, point of diversion, and place of use of the water. Further, with respect to water used for irrigation, the decree also typically declares the parcels of land to which a particular right applies.

Water Rights Changes (California Water Code, § 1707). California Water Code, § 1707 authorizes any person entitled to the use of water to petition SWRCB for a change to the person's existing water right for purposes of preserving or enhancing wetlands habitat, fish and wildlife resources, or recreation in or on the water.

Applicable Local/County Regulations

Siskiyou County General Plan

The Conservation Element of the Siskiyou County General Plan (Siskiyou County, 1973) includes some general objectives relating to hydrology, water resources, and water quality. These objectives include:

- To preserve and maintain streams, lakes and forest open space as a means of providing natural habitat for species of wildlife;
- To preserve the quality of existing water supply in Siskiyou County and adequately plan for the expansion and retention of valuable water supplies for future generations and to provide for a comprehensive program for sustained multiple use of watershed lands through reduction of fire hazards, erosion control and type-conversion of vegetation where desirable and feasible.

3.2.3 Impacts and Mitigation Measures

Significance Criteria

Significance criteria, or thresholds, listed in Appendix G in the California Environmental Quality Act (CEQA) *Guidelines* may be used to determine the significance of a project's potential impacts. Additional (or more specific) criteria and objectives derived from other agencies or documents (e.g., NCRWQCB water quality standards), and determined to be appropriate based on Program-specific considerations, have also been incorporated within the context of Appendix G.

Some of the criteria listed in Appendix G of the CEQA *Guidelines* are not applicable to the Program or otherwise do not merit further discussion. Specifically, the Program is not anticipated to have a potentially significant impact in regard to some of the flood-related criteria in Appendix G. These criteria include exceeding the capacity of stormwater drainage systems, placing housing within a flood hazard area, or exposing people or structures to significant risk of loss, injury, or death involving flooding. Furthermore, the Program Area is not subject to inundation by seiche or tsunami. Parts of the Program area may experience mudflows or be relatively more susceptible to mudflow hazards. Mount Shasta, in the southeast portion of the Shasta River watershed, is an active volcano whose latest flows are probably not more than a few centuries old. An eruption or another kind of extremely rare, catastrophic seismic event on Mount Shasta could trigger a lahar, debris avalanche, or mudflow-like event capable of filling the entire Shasta Valley (such as occurred some 300,000 years ago) and destroying every structure therein, including those constructed as part of the Program. However, such events are extremely rare and the potential risk of loss involving a mudflow (or debris avalanche) is not considered significant in this document. The significance criteria addressed above are not discussed further in this Draft EIR. The significance criteria in Appendix G that are pertinent to the Program, as well as applicable water quality objectives identified by NCRWQCB (2006c), are listed below. Using these criteria, a project or program would normally result in a significant hydrology- and water quality-related impact if it would:

Water Quality

- Cause or contribute to violations of ambient water quality objectives by substantially 1) reducing dissolved oxygen concentrations and 2) altering the ambient temperature of receiving waters such that one or more beneficial uses are adversely affected.

- Otherwise substantially degrade water quality or provide substantial additional sources of polluted runoff, including degradation of stream or river characteristics related to cold freshwater habitat.

Groundwater

- Substantially deplete groundwater supplies or interfere with groundwater recharge.

Surface Water Drainages

- Substantially alter channel stability (erosion or sedimentation rates) through increases or decreases in flow or sediment supply.

- Substantially alter channel stability by changing the course or hydraulic characteristics of a stream or river.

Flooding

- Substantially impede or redirect flood flows

In addition to these considerations, the reader is referred to the discussion of existing conditions, significance criteria, and potential impacts contained in Chapter 3.3, Impact 3.3-1.

Impact Analysis

Impact 3.2-1: Certain construction activities performed under the Program could result in increased erosion and sedimentation and/or pollutant (e.g., fuels and lubricants) loading to surface waterways, which could increase turbidity, suspended solids, settleable solids, or otherwise decrease water quality in surface waterways (Significant).

Construction activities associated with the Program could increase the turbidity or otherwise degrade the water quality of receiving channels and waterways. This is a potentially significant impact. Activities that disturb ground within the floodplain, banks, or bed of a channel could make soils and sediments more susceptible to erosion. Increased erosion rates would likely lead to increased sediment concentrations and turbidity levels in the receiving channel(s) and to the subsequent degradation of aquatic habitats. Also, moderate increases in runoff from construction areas could initiate or exacerbate an erosion and sediment delivery problem. An increase in the runoff rate from the construction area may result from temporarily decreasing the resistance to overland flow (e.g., clearing of native vegetation or on-slope grading), decreasing the infiltration capacity of the soil through compaction, and/or by increasing the velocity of runoff (e.g., concentrating flow into manmade features or into existing rills or gullies). Further, if construction equipment or workers inadvertently release pollutants (e.g., hydraulic fluid or petroleum) on site, these compounds could be entrained by runoff and discharged into receiving channel(s) causing water quality degradation. The extent of erosion or pollution that could occur at any given project site varies depending on soil type, vegetation/cover, and weather conditions.

Most of the Covered Activities and proposed mitigation measures that would require construction involve short-term (i.e., within a single season) construction activities, and thus the associated potential impacts would be temporary in nature. Covered Activities and measures that include notable construction components include maintenance, installation, and removal of water diversion structures; installation and maintenance of fish screens; construction and maintenance of stream crossings; riparian restoration and revegetation; installation, maintenance, and repair of instream structures; and barrier removal projects including fish ladder and boulder weir installations and channel restoration projects. Specific construction activities referenced under this potential impact include, but are not limited to, use of heavy machinery including loaders and backhoes within and near the channels, shallow excavation within and near the channels, moving bed material within the channels, and establishing and grading staging areas for equipment, machinery, and vehicles.

Program measures, as well as adherence to federal and state water quality standards, would help protect water quality during construction activities. As discussed above, if as part of the Program a Covered Activity performed at a single project location will disturb a total of one acre or more of land, SVRCD or the Agricultural Operator performing the project will submit a NOI to SWRCB to obtain coverage for the activity under the General Permit. The preparation of a SWPPP would be required in accordance with the General Permit. The SWPPP would include, but not be limited to, relevant measures, conditions, and obligations already described as part of the Program which would reduce the impacts of construction activities on stormwater and receiving water quality and quantity. However, even for cases where a General Permit would not be required, such as a project which would disturb less than one acre of land, the Program measures, conditions, and obligations that would protect water quality during construction activities would still be implemented.

Covered Activities that involve or are expected to involve dredge or fill, and discharge of waste, are subject to water quality certification under section 401 of the CWA and/or waste discharge requirements under the Porter-Cologne Act. SWRCB's Division of Water Rights processes section 401 water quality certifications on projects that involve water diversions (California Code of Regulations, title 23, § 3855). Chapter 4, Article 4 of the Porter-Cologne Act (California Water Code, § 13260-13274), states that persons discharging or proposing to discharge waste that could affect the quality of waters of the state (other than into a community sewer system) shall file a Report of Waste Discharge with the applicable RWQCB. For discharges directly to surface water (waters of the United States) an NPDES permit is required, which is issued under both state and federal law; for other types of discharges, such as waste discharges to land (e.g., spoils disposal and storage), erosion from soil disturbance, or discharges to waters of the state (such as isolated wetlands), Waste Discharge Requirements (WDRs) are required and are issued exclusively under state law. The WDR application process is generally the same as for CWA section 401 water quality certification, though in this case it does not matter whether the particular project is subject to federal regulation. The project proponent would contact the NCRWQCB, who would determine whether WDRs or a waiver of WDRs is required.

Also, as discussed above, it is up to the individual project proponent (e.g., the Agricultural Operators and SVRCD) to contact the relevant federal agency(s) in order to determine whether that federal agency(s) would take jurisdiction on a specific project and require a permit; if a federal permit is required then the project proponent would be required to also obtain water quality certification from NCRWQCB. In addition, the project proponent would contact NCRWQCB and determine whether an issuance or a waiver of WDRs is required.

However, with respect to controlling erosion and pollutant issues during project construction (and even project operation, in most cases), the conditions and obligations within the Incidental Take Permit (ITP) and Master List of Terms and Conditions (MLTC) are comprehensive and either meet or exceed the provisions normally stipulated in water quality certifications and WDRs. Aside from the seasonal issue discussed below, the Program measures that would protect water quality during construction activities are intended to be appropriate and sufficient with respect to federal and state water quality protection standards.

Of particular concern regarding potential erosion and pollutant impacts is the time of year when construction activities would be allowed. The risk of erosion, sediment delivery, and pollutant loading would be of most concern during the winter and spring, when significant rainfall and runoff occurs. To minimize this risk, the season for instream equipment operations and work related to structural restoration projects is limited to the period from July 1 to October 31, according to ITP General Conditions (g) and (h) (Article XIII.E.1). Much of this season typically experiences little rainfall and runoff. However, summer thunderstorm events and early winter storms could still occur during the period from July 1 to October 31, and the potential for early storms increases substantially in the second half of October. Therefore, though the Program measures and regulatory requirements would be adequate to control potential construction-related water quality impacts through the early fall, allowing the construction period to continue through the end of October poses a potentially significant impact to water quality.

Mitigation Measures Proposed as Part of the Program

Mitigation Measure 3.2-1a: ITP General Condition (b) (Article XIII.E.1) requires the immediate containment and clean-up of any fuel, lubricants, or other hazardous materials that leak or spill that occurs during a Covered Activity.

Mitigation Measure 3.2-1b: ITP Additional SVRCD and Sub-Permittee Avoidance and Minimization Obligation F. – Push-Up Dams and Obligation G. - Other Temporary Diversion Structures (Article XV) requires preparation and adoption of a set of Best Management Practices (BMP) governing the construction, operation, and removal of push-up dams and other temporary diversion structures other than push-up dams.

Mitigation Measure 3.2-1c: The MLTC includes the following conditions which will reduce the potential for construction-related impacts to water quality:

A. Water Diversions: Conditions 31, 34, and 39;

B. Instream Structures: Conditions 58-60;

C. Use of Vehicles in Wetted Portions of Streams: Conditions 65-67;

D. Pollution Control: Conditions 68-75;

E. Erosion and Sediment Control: Conditions 76-84;

F. Dewatering: Conditions 89-92, 94, 96-98; and

G. Ground-Disturbing Activities: Condition 108.

Mitigation Measures Identified in this Draft EIR

Mitigation Measure 3.2-1d: The season for instream construction activities and equipment operations shall be limited to the period from July 1 to October 15. If weather conditions permit and the stream is dry or at its lowest flow, instream construction activities and equipment operations may continue after October 15, provided a written request is made to CDFG at least five days before the proposed work period variance. Written approval from CDFG for the proposed work period variance must be received by the SVRCD or Agricultural Operator prior to the start or continuation of work after October 15.

If work is performed after October 15 as provided above, the SVRCD or Agricultural Operator will do all of the following:

A. Monitor the 72 hour forecast from the National Weather Service. When there is a forecast of more than 30 percent chance of rain, or at the onset of any precipitation, the work shall cease.

B. Stage erosion and sediment control materials at the work site. When there is a forecast of more than 30 percent chance of rain, or at the onset of any precipitation, implement erosion and sediment control measures.

Level of Significance after Mitigation

Implementation of Mitigation Measures 3.2-1a through 3.2-1d would substantially reduce the potential for erosion and pollution from project construction sites and, as a result, construction activity-related impacts on water quality (e.g., turbidity) would be reduced to a less-than-significant level.

Impact 3.2-2: Certain instream structures proposed to improve fish habitat as part of the Program would be installed within a flood hazard area and could impede or redirect flood flows (Less than Significant).

Some of the instream structures proposed as part of the Program would be installed within a 100-year flood hazard area as defined by FEMA (2004); these structures include water diversion structures (including weirs), fish screens, fish ladders, stream crossings, and structures related to channel restoration projects. Such structures, placed within the stream channel, could impede or redirect flood flows. However, water diversion structures and fish ladders installed as part of the Program would improve fish passage conditions at currently impassable (or difficult to pass) locations or alleviate existing impediments to flow (e.g., replacing dams with weirs that are lower in elevation). In doing so, they would provide for more natural passage of low to moderate flows. These structures would be submerged during floods and exert little resistance upon flood flows. Likewise, fish screens, stream crossings, and restoration-related structures would not be expected to impede or redirect flood flows. This impact would therefore be less than significant.

Mitigation Measures

This potential impact was determined to be less than significant. No mitigation measures required.

Impact 3.2-3: Installation and operation of instream structures permitted under the Program could alter channel stability and degrade water quality by increasing turbidity downstream (Significant).

As part of the Program, CDFG would require and permit the installation and operation of instream structures under ITP Covered Activity 4 (Stream Access and Crossings), ITP Covered Activity 7 (Instream Structures), ITP Covered Activity 9 (Barrier Removal and Fish Passage Projects), and ITP Covered Activity 12 (Permit Implementation). These activities and measures are intended to either improve fish passage and habitat within the Program Area or control activities (such as cattle and vehicle crossings) that could damage streambanks or channels. Structures included in this potential impact are: boulder weirs, angular rock, bioengineered habitat structures, large woody debris (LWD), fish ladders, and other channel restoration or protection measures, some of which may span the width of a channel. Although the purpose of such structures is to improve habitat, as discussed below, on a reach-scale such structures have the potential to alter channel stability and influence water quality by altering sedimentation and turbidity downstream. This would be a potentially significant impact.

Instream structures may increase sediment deposition on their upstream side and induce erosion and scour immediately downstream. Lower flows (on the order of one half the bankfull discharge and lower) typically do not transport much sediment or induce channel bed and bank scour in gravel-bed streams, and therefore these flows are not a concern regarding this potential impact. The bankfull flow[11] (or range of intermediate high flows) occurs, on average, once every one to two and a half years and, over the long-term, tends to move the most sediment in a gravel-bed stream (Dunne and Leopold, 1978; Simon and Castro, 2003; Schmidt and Potyondy, 2004). Higher flow events (10-year flood, 25-year flood, etc.) move more sediment in a single event but with much less frequency.

If instream structures are too large or too high, they could impede the sediment transport processes that occur during larger flow events. Depending on the amount of sediment being carried into the reach of interest, these structures could alter the transport capacity of bankfull flows and cause deposition on the upstream side; if this continues to occur and the channel begins to aggrade (e.g., to cause an increase in the overall bed elevation), then this location could serve as an elevation control for the entire reach and ultimately promote further deposition upstream and exacerbate erosion immediately downstream of the structure. If the change in water surface elevation between the upstream and downstream side is great enough, these structures could induce erosion near the base and immediately downstream, as well as dissipate the flow energy to the point that the capacity for bankfull flows to move sediment from the downstream reach is notably decreased.

For structures intended specifically to improve fish habitat and passage, studies have illustrated various problems and various success rates (Frissel and Nawa, 1992; Roper et al., 1998; Niezgoda and Johnson, 2006). Roper et al. (1998) concluded that instream structures are most appropriate when used as short-term tools to improve degraded stream conditions while activities that caused the habitat degradation are simultaneously modified. The stability of instream structures would be of particular concern in the higher-order stream segments within the lowland and valley areas.

Mitigation Measures Proposed as Part of the Program

Mitigation Measure 3.2-3a: ITP Additional SVRCD and Sub-Permittee Avoidance and Minimization Obligation D.4. - Livestock and Vehicle Crossings (Article XV) requires annual monitoring of all livestock and vehicle crossings installed under the Program. If the crossing is exacerbating erosion and contributing fine sediment to the stream, SVRCD shall note that in its Annual Report and the sub-permittee shall be responsible for remediation of the problem.

[11] Bankfull flow is hereinafter used in the plural, “bankfull flows” or “bankfull flow conditions,” to emphasize that this term does not invoke a single or static flow rate, but rather a limited range of intermediate high flows at or near the bankfull extent.

Mitigation Measure 3.2-3b: MLTC Conditions 35 41, 45, and 53 would ensure that boulder weirs are sized to resist wash-out and do not create lifts in the stream channel that exceed twelve (12) inches, and that instream structures shall be designed and implemented in accordance with CDFG's Salmonid Stream Habitat Restoration Manual.

Mitigation Measures Identified in this Draft EIR

Mitigation Measure 3.2-3c: CDFG and SVRCD shall establish performance criteria for new and replacement instream structures including boulder weirs, angular rock for bank protection, bioengineered habitat structures, large woody debris, fish ladders, and other channel restoration or protection measures. The performance criteria shall include, but not be limited to, the following:

- Sediment deposition upstream and erosion/scour and subsequent deposition downstream of these instream structures, during bankfull flow conditions, would be avoided to the extent feasible, unless the intent of the particular structure is to facilitate such processes (e.g., gravel trapping);
- Instream structures shall not alter channel hydraulics such that the project reach can no longer move the imposed sediment load (e.g., upstream supply) with the available range of sediment-transporting flows; this criterion shall focus on the transport of bed-material load;
- Instream structures shall not lead to a permanent increase in the downstream transport of sediments that is outside the historical range of sediment flux; and
- Instream structures shall be designed to withstand a given range of flows (e.g., some structures are permanent, such as fish ladders, while other structures are "semi-permanent," such as placement of LWD). The range of flows that a particular structure will be designed to handle shall be quantified and rationalized.

Engineered structures such as fish ladders and boulder weirs designed for grade control, or for fish passage in proximity of a water diversion, require design and assessment by a qualified hydrologist, geologist, engineer, or other similarly qualified individual using methods and levels of rigor that have been established in the engineering and scientific community. Based on the assessment, if the proposed structure would fail to meet the performance criteria, then the structure shall not be installed within that particular reach.

The performance criteria shall be included in the SVRCD ITP Monitoring and Adaptive Management Plan (ITP Attachment 3) and their verification and effectiveness shall be included in the Monitoring (ITP Covered Activity 13) or Research (ITP Covered Activity 14) activities of the Program.

Level of Significance after Mitigation

Implementation of Mitigation Measures 3.2-3a through 3.2-3c would reduce the potential channel stability and water quality impacts to a less-than-significant level.

Impact 3.2-4: The Program could result in an increase in the extraction of groundwater, which could contribute to decreased baseflows and increased ambient water temperatures in the Shasta River and its tributaries (Less than Significant).

Most of the surface water resources in the Program Area are fully appropriated and have been adjudicated under the Shasta River Decree. Hence, an Agricultural Operator who needs additional water for irrigation may find it easier to meet that demand by using groundwater. As discussed above, the Program will not cause an increase in the use of groundwater by Agricultural Operators to *add* to the amount of water they already obtain through their surface water diversions. However, the Program could indirectly result in an increase in the use of groundwater if the measures that apply to surface water diversions included in Streambed Alteration Agreements (SAAs), the ITP, and sub-permits issued under the Program pose regulatory, economic, or other burdens that an Agricultural Operator could avoid by *substituting* all or part of its surface water diversion(s) for groundwater. The extraction of groundwater for irrigation is not a Covered Activity under the Program. However, any need for water by Agricultural Operators in addition to the amount of surface water they are entitled to divert and use would be driven by factors independent of the Program, namely increased development within the watershed and the fluctuation of commodity prices (e.g., lower commodity prices would increase the pressure to produce more or to switch to crops with higher market values but which are potentially more water intensive, such as alfalfa). The Program could also directly result in an increase in the use of groundwater because, under the Program, groundwater supplies may be used as one alternative means to satisfy stock water demands from October through December as a means of enhancing surface flows during dry conditions and during critical times of the year to improve salmonid habitat (see ITP Mitigation Obligations of SVRCD (a)(iv) (Article XIII.E.2)).

Increased use of groundwater during dry conditions in order to curb the consumptive use of surface water, as proposed by the Program, could decrease groundwater discharge into the Shasta River and its tributaries. A reduction in groundwater discharge could decrease baseflow volumes and could contribute to increased water temperatures. Groundwater and subsurface flow contribute cool water, directly and indirectly (e.g., by means of spring and seep maintenance), to surface stream channels in the Program Area. As shown by NCRWQCB (2006a), spring flow input can dramatically reduce the ambient water temperature within the mainstem Shasta River. However, due to the complex geology that makes up the Shasta Valley groundwater basin, the inter-relationship between groundwater and surface water in the Program Area is still not well understood. During low flow conditions, if groundwater is pumped in the proximity of a flowing stream or a subsurface channel such that subterranean flow is impacted than that groundwater extraction could result in a decrease in instream flow and, concomitantly, an increase in water temperatures in the nearby stream.

Any increase in groundwater use under the Program is expected to be low for the following reasons: 1) the proposed scale of the alternative stock watering system is small; the Program specifies the installation of two systems per year within the entire Program Area; 2) not all such systems would necessarily use groundwater, as alternative methods are also proposed; 3) groundwater irrigation tends to cost more (for well installation, piping, and power costs); and 4) the availability of groundwater resources in the Shasta Valley varies greatly from location to location. As to the latter, in the northern portion of the Valley where the majority of irrigated lands exist, groundwater resources are generally less productive compared to areas within the eastern portion of the Valley that overlie the basalt formations.

Because it is not likely that the Program would cause a substantial increase in the use of groundwater, the level of any impacts associated with such use would be low. Further, for the season in which the alternative stock watering system is proposed for use, October through December, the *volume* of streamflow is as much of a concern for salmonid habitat as the temperature of the water. High water temperatures are of principal concern and exert more influence on limiting salmonid habitat in the summer and early fall months. In addition, some Agricultural Operators must divert much more surface water than is needed to satisfy their stock-watering needs, because a higher volume of water is necessary to enable water to flow from the point of diversion to the point of use to accommodate for carriage loss due to varying delivery efficiencies. Hence, in some cases, substitution of groundwater for surface water would result in a reduction in the amount of water diverted.

As such, with respect to the impact that alternative stock watering systems may have on surface water temperatures, this potential impact is less than significant.

Mitigation Measures

This potential impact was determined to be less than significant. No mitigation measures required.

References

Ayres and Associates, 1999, *Geomorphic and Sediment Evaluation of the Klamath River, California, below Iron Gate Dam*, prepared for USFWS, 300 pages.

California Geological Survey (CGS) – See State of California.

Crandell, D.R., 1989, *Gigantic Debris Avalanche of Pleistocene Age from Ancestral Mount Shasta Volcano, California, and Debris-Avalanche Hazard Zonation.* U.S. Geological Survey Bulletin 1861.

Deas, M.L., A. Abbott, and A. Bale, 2003, *Shasta River Flow and Temperature Modeling Project,* April, 2003.

Department of Fish and Game (CDFG) – See State of California.

Department of Water Resources (DWR) – See State of California.

Dunne, T., and L.B. Leopold, 1978, *Water in Environmental Planning*. W.H. Freeman and Company, New York.

Federal Emergency Management Agency (FEMA), 2004, Q3 Flood Data, California. Digital database (ArcGIS), Disc 1.

Frissell, C.A., and R.K. Nawa, 1992, *Incidence and Causes of Physical Failure of Artificial Habitat Structures in Streams of Western Oregon and Washington.* North American Journal of Fisheries Management, 12:182-197

Hilmes, M.M. and E.E. Wohl, 1995, *Changes in channel morphology associated with placer mining*. Physical Geography, 16: 223-242.

Kier Associates, 2005, *Review of the public draft of the Scott River Watershed TMDL. Performed under contract to the Klamath Basin Tribal Water Quality Work Group*, Kier Associates, Mill Valley, CA.

Klamath Resource Information System (KRIS), 2007, Background, Geology, and River Overviews: Shasta River, Shasta River Basin Geology and Shasta River Hydrology, www.krisweb.com, accessed March 2007.

LaPlante, D, 2001, *Parks Creek Sediment Source Assessment*, under contract to Great Northern Corp., grant funding from Calif. Department of Fish and Game.

Mack, S., 1960, *Geology and Ground-Water Features of Shasta Valley, Siskiyou County California.* U.S. Geological Survey Water-Supply Paper 1484.

National Research Council (NRC), 2004, *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery*, The National Academy Press, Washington D.C.

Niezgoda, S.L, and P.A. Johnson, 2006, "Modeling the Long Term Impacts of Using Rigid Structures in Stream Channel Restoration." *Journal of the American Water Resources Association* (JAWRA), 42(6):1597-1613.

North Coast Regional Water Quality Control Board (NCRWQCB) – See State of California.

Roper, B., Konnoff, D., Heller, D., and K. Wieman, 1998, "Durability of Pacific Northwest Instream Structures Following Floods," *North American Journal of Fisheries Management*, 18:686-693.

Schmidt, L.J., and J.P. Potyondy, 2004, *Quantifying Channel Maintenance Instream Flows: An Approach for Gravel-Bed Streams in the Western United States.* U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-128, May, 2004.

Simon, A., and J. Castro, 2003, "Measurement and Analysis of Alluvial Channel Form." In, G.M. Kondolf and H. Piegay, eds., *Tools in Fluvial Geomorphology*. John Wiley & Sons Ltd, pp. 291-322.

Shasta Valley Resource Conservation District (SVRCD), 2005, *Incidental Take Permit Application for Coho Salmon*. Submitted to California Department of Fish and Game, March 29, 2005.

Siskiyou County, 1973, *Siskiyou County General Plan, Conservation Element*, June 1973.

Sommarstrom, S., Kellog, E., and J. Kellog, 1990, *Scott River Watershed Granitic Sediment Study*. Prepared for the Siskiyou County Resource Conservation District, November 1990.

State of California, California Data Exchange Center (CDEC), 2007. Accumulated monthly precipitation data for Yreka, CA (CDEC Station ID: YRK), cdec.water.ca.gov/cgi-progs/staMeta?station_id=YRK, accessed January, 2007.

State of California, Department of Fish and Game (CDFG), 2004, *September 2002 Klamath River Fish-Kill: Final Analysis of Contributing Factors and Impacts,* July 2004.

State of California, Department of Water Resources (DWR), 1964, *Bulletin No. 87, Shasta Valley Investigation.* July, 1964, 170 p.

State of California, DWR, 1994, *Draft, Shasta Valley Groundwater Resources Inventory Analysis, Domestic and Irrigation Well Depth Data with Corresponding Hydrographs,* Appendix A. Prepared for the Shasta Valley Resource Conservation District.

State of California, DWR, 2004, *California's Groundwater, Shasta Valley Groundwater Basin.* California Department of Water Resources, Bulletin 118.

State of California, DWR, 2006, *Siskiyou County Land Use GIS database,* 2006.

State of California, DWR, 2007, Draft Shasta Valley Data Needs Assessment, November 2007, Appendix A.

State of California, California Geological Survey (CGS), 2002, *California Geomorphic Provinces*, Note 36, revised December 2002.

State of California, North Coast Regional Water Quality Control Board (NCRWQCB), 2006a, *Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads*, June 28, 2006.

State of California, NCRWQCB, 2006b, *Proposed 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments.* Approved by the SWRCB on October 25, 2006. Accessed online May 2007, www.waterboards.ca.gov/centralcoast/TMDL/index.htm.

State of California, NCRWQCB, 2006c, *Water Quality Control Plan for the North Coast Region.* September 2006, www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/, accessed December 2006

State of California, State Water Resources Control Board (SWRCB), 1990, *State Water Resources Control Board Information Pertaining to Water Rights in California*.

State of California, SWRCB, 1998, *Water Right Order 98-08: In the Matter of the Declaration of Fully Appropriated Stream Systems in California: Various Stream Systems, Statewide in All Counties Except Imperial and San Francisco,* www.waterrights.ca.gov/hearings/wro1998.html.

State of California, SWRCB, 1999, *NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit) Water Quality Order 99-08-DWQ.*

State of California, SWRCB, 2004, "Dissolved Oxygen Fact Sheet, FS-3.1.1.0(DO)." In: *The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment*, Version 2.0, Division of Water Quality.

U.S. Environmental Protection Agency (USEPA), 1986, *Ambient Water Quality Criteria for Dissolved Oxygen.* Office of Water, EQP 440/5-86-003, 46 p.

U.S. Geological Survey (USGS), 2007, Flow Data for 11517500 Shasta River near Yreka, CA, waterdata.usgs.gov/ca/nwis/sw, accessed March 2007.

Vignola, E. and M.L. Deas, 2005, *Lake Shastina Limnology.* Prepared for the University of California, Davis and the North Coast Regional Water Quality Control Board, April 8, 2005.

Vose, R. S., R. L. Schmoyer, P. M. Steurer, T. C. Peterson, R. Heim, T. R. Karl, and J. K. Eischeid, 1992, NDP-041, The Global Historical Climatology Network: Long-Term Monthly Temperature, Precipitation, Sea Level Pressure, and Station Pressure Data. Data set updated through December, 2003 (version 2), cdiac.esd.ornl.gov/epubs/ndp/ndp041/ndp041.html

Wagner, D.L. and G.J. Saucedo, 1987, *Geologic Map of the Weed Quadrangle*, Scale 1:250,000. Regional Geologic Map Series, California Geological Survey [formerly Division of Mines and Geology].

Webb, David, Shasta Valley Resource Conservation District (SVRCD), Yreka, CA, personal email communication on March 22, 2007.

Western Regional Climate Center (WRCC), Desert Research Institute, 2007, Northern California Climate Summaries, www.wrcc.dri.edu/summary/climsmnca.html, accessed March 2007.

Wohl, Ellen, 2005, "Compromised Rivers: Understanding Historical Human Impacts on Rivers in the Context of Restoration," *Ecology and Society*. 10(2).